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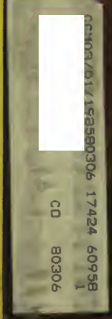

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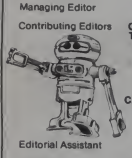

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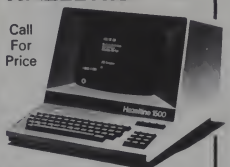

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ANOTHER BUBBLE BURSTS

David H. Ahl

In the June column I mentioned that Rockwell was pulling out of the bubble memory arena. Now they have been followed by industry giant Texas Instruments. This leaves Intel and National Semi as the chief producers of bubble memory components with Motorola still promising a product announcement before year's end. Thus, it looks less likely that a solid state device will replace disk storage devices on a mass level in the near future as was so widely forecast as little as 18 months ago.

TI 99/4 OUT. TI 99/4A IN.

Plagued by buyer resistance to its strange keyboard and high list price, TI plans to withdraw the 99/4 and replace it with an updated model, the 99/4A. The new machine has a standard keyboard with upper and lower case and carries a retail price of $525. This is $125 less than the current, twice reduced price of the 99/4.

Will a 16K 99/4A sell at $525? Direct competitors include the 16K Atari 400 at $399 (but with a membrane keyboard), the 16K TRS-80 Color Computer at $399 and the Commodore VIC-20 with 5K at $299. Our verdict: too little and too late.

WITHER IBM?

In April I mentioned that IBM has something small up its corporate sleeve. The details are beginning to shape up: it will be based on the 16-bit Intel 8088 mpu and be able to address up 256K. Two 5-1/4" floppy disk drives are included, one of which can be replaced by a Winchester. The operating system is similar to CP/M. Price is anybody's guess.

AND XEROX

Hot on the heels of the Xerox Star announcement (see NCC Report on page 28) comes another even lower end machine, the 820, designed to compete with intelligent word processing machines like the IBM Displaywriter, Wang and CPT. Like the Star, it can hook in to the Ethernet network.

Based on a Z80A, the machine uses the CP/M operating system. This positions it squarely in the midst of the microcomputer market which, to date, has avoided the attention of the giants. Base price of the machine with a dual disk drive and display is $2995; with printer this goes to $6000.

THE BIZARRE WORLD OF LAWYERS AND PATENTS

Patent 4,235,442 was issued to Fidelity Electronics covering "electronic board game systems such as games normally played between two competitors, wherein the 'game' substitutes for the second competitor."

A Fidelity press release proclaims that "patent infringement proceedings are being considered against a number of companies, representatives, distributors, wholesalers, and retailers." Indeed, an entire industry is vulnerable.

The next thing you know someone will be issued a patent covering all computer games in which the 'game' plays the role of the second competitor. "Ridiculous," you say. But apparently the lawyers don't think so. It's a bizarre world in which we live.

DON'T ASK

An alarming number of readers have called or written asking for further information on items mentioned in this column. "Alarming" because I can't possibly answer all the inquiries. And for the most part, I rarely have much additional information. As soon as a product becomes commercially available, we will review it in Creative.

If you have any information that ought to appear in this column, please send it along. Thanks!

Invasion Orion: Can You Defeat The Klaatu and Your Computer?

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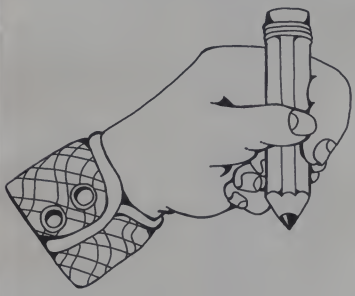


In The Cards

Dear Editor:

If hackers wish to re-invent the wheel, fine; let them. But Rogowski is stone chipping with his fingernails in "Cat Card" (*Creative Computing*, May 1981). Why a manual system when his program can search, add, re-alphabetize, delete, or print-out a bibliography by author, title, type, or "who has got my stuff?" if preferred?

Since assigned numbers and subjects are so readily available, so expandable, the thought of resystematizing anything boggles the mind. His little (!) caution, "always be aware of where the card . . . will fit," is revelation enough.

We produce inventories, print-outs of lists from all keyed information, and could do cards, if we needed them. Rogowski reminds one of those monks who copied all early printed books back on to parchment, hating to give up the old ways. Both his approach and his product deny his computer's great facility at cataloging.

Betty M. Minemier
Librarian Media Specialist
Junior High School
Dansville, NY 14437

XOR Size

Dear Editor:

I enjoyed Charles Noah's article, "Protect Those Data Files," in the March issue.

Below is an alternate program for encoding/decoding strings using XOR's. It has the same effect that Mr. Noah's program would if a separate key were provided for each position of the character string. However, this program requires only one key. This key, which may be integer or non-integer, is used to "seed" the random number generator. Many Basic interpreters allow use of a seed. This program is written in Microsoft Basic.

```
10 INPUT "ENTER YOUR KEY - ";KV
20 LINE INPUT "ENTER A STRING: ";A$
30 GOSUB 9000  ' SCRAMBLE THE STRING
40 PRINT "SCRAMBLED STRING: ";A$
50 GOSUB 9000  ' DE-SCRAMBLE THE STRING
60 PRINT "ORIGINAL STRING: ";A$
70 END
9000 REM ENCODE/DECODE STRING A$
9010 X=RND(-ABS(KV))
     ' RESTART RANDOM GENERATOR
9020 FOR I=1 TO LEN(A$)
9030 MID$(A$,I,1)=CHR$(ASC(MID$(A$,I,1)) XOR INT
     (256*RND(1)))
9040 NEXT I
9050 RETURN
```

Paul Schaefer
2315 Crestbook
Flint, MI 48507

Under Control

Dear Editor:

There is one problem that has been puzzling me for a long time. It is how to put a password on your program to prevent the running of it and not be able to stop it. Also accompanying this problem hand-in-hand is the question on how to prevent the person from just loading the program, listing it and take out the password routine and then run it and save it. I have had several experiences of people stealing my programs from my diskette. The computer I am refering to is the Apple II. I hope you are able to help me on this problem. I have written to the company but in vain. Thank you for your time.

Marco Matchefts

P.S. A perfect example of an excellent routine is Applechess 2.0.

There are many ways to protect programs. The simplest technique to use with Apple disks is to add control characters to program titles when saving the programs. These characters won't appear on the screen during a CATALOG list. The only problem is that you have to remember both which characters were used and where in the title they were used, or you won't be able to run your own program. To enter the control characters, just type them using any non-reserved letter along with the control key. Certain characters (such as control-X or control-H) can't be entered through the keyboard, since they perform certain functions. There are ways to enter reserved characters, but that goes beyond the scope and space of this reply. This type of protection can keep someone from running your program, but it doesn't help with the problem of how to allow someone to run, but not to copy, your program. If there is reader interest, I'll try to cover some protection techniques in detail.—D.L.

ut...input/output...in

Imaginary Strings

Dear Editor:

After reading the article on APF'S Imagination Machine, May '80, I became interested in it.

Looking further I found out that the statement about the lack of string functions was misleading. Although it wasn't very clear in the Basic Manual, it is possible.

Left $(A$,X) becomes Dim B$(X-1): B$=A$

Right $(A$,X) becomes Y=Len(A$): Dim B$(X-1): B$=A$(L-X-1)

Mid $(A$,X,Y) becomes Dim B$(Y-X): B$=A$(X-1)

where B$ represents the new string fragment.

Gregory Forseth
9240 Golden Valley Rd.
Golden Valley, MN 55427

Pardon Me Boys, Is That The Chart That Knew The Future?

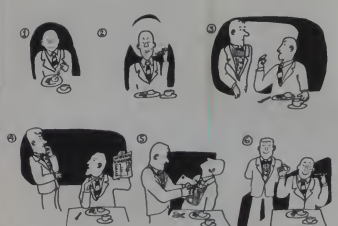
Dear Editor:

I am a "Chartist," and after reading the 3rd paragraph in the disclaimer following the article "Investing in Mutual Funds" by John S. Browning (May 1981, *Creative Computing*) I feel like I practice Witchcraft and await burning at the stake. You have touched on the war between the Fundamentalist and the Chartist: between good and evil.

Yes, we do claim our chart formations act as a guide in stock selections and timing, but to say without proof as Mr. Browning did that "few statisticians believe in these methods" is not fair play in anyone's cauldron!

A quick scan of Financial publications will reveal articles by well-known professionals on the merits of technical analysis. True, the method is not infallible but then neither is fundamental analysis.

Patrick J. Calabrese
906 E. 21st St.
Erie, PA 16503



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Satisfied Customer

Dear Editor:

I was quite delighted to see your recognition of "The Computer Works" as your Computer Store of the Month in the May issue of *Creative Computing*. Since 1977 I have been a very satisfied customer of Herman Axelrod. He started me in personal computing, guided me correctly in the selection of hardware and has offered me invaluable advice regarding software and problem solution ever since. His associates are knowledgeable and helpful. His service organization is excellent, prompt and experienced.

As a complete neophyte when I started, to me one of the most important characteristics Herman exhibited, in addition to his honesty and knowledge, was and has been his patience.

In my opinion, the Computer Works can stand as an excellent example of what a computer store should be.

Carlos E. Milner Jr.
1318 S. Crystal Way
Aurora, CO 80012

Radical Problem

Dear Editor:

I own an Apple and I have just recently found *another* Applesoft bug. Have you ever noticed that program A will not work with any number unless it is a multiple of 4. This program will always tell you that the square of your number is a non-integer, unless of course you enter a multiple of 4 (like 4 or 16 or 64). Program B seems to solve this problem. This program will correctly tell you the nature of the roots no matter what the number. Any reason why this is happening?

Program A.

```
10 input "Number? ";A
20 X = SQR(A)
30 if  X = INT(X) THEN PRINT "The roots of this number are
integers!";:GOTO 50
40 PRINT "The roots of this number are non integers"
50 GOTO 10
60 END
```

Program B.

```
SAME AS ABOVE, ONLY ADD THIS LINE.
15 X$ = STR$(X) : X = VAL(X$)
```

Geoffrey Raynor
935 Park Ave.
New York, NY 10028

The problem, and the immunity of powers of four, are caused by the way computers handle numbers. A floating-point number is stored with more places than are displayed. Thus a number that is printed as 3.01 might actually be stored as 3.0100000007. The square-root function produces results that will be accurate as far as display is concerned. The external display SQR(36) will be 6. Internally, the number might contain a fractional value in the far end of the decimal portion.

The reason that powers of four don't suffer this problem was pointed out to us by Mark Pelczarski. Since the Apple converts numbers to binary before carrying out any calculations, slight errors will be produced when dealing with floating-point values that don't have exact binary equivalents. For example, 4.5 decimal is readily translated to 100.1 binary.

Coupling the difference between internal and external handling of numbers with the round-off errors produced by conversion from decimal to binary to decimal, you can see that numbers displayed as integers might not be stored that way. Whenever a test for integers is made, it is best to use an intermediate step such as the one used by Mr. Raynor. —D.L.

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(LISP)

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Tape 2, 27 programs from Osborne book $10.95
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Tape 5, 24 buts., edu., game progs. $10.95
Tape 7, 31 buts., edu., game progs. $10.95
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Tape 9, 25 buts., edu., game progs $10.95
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NewDOS-80 (Model 1 or 3?)	$111
DOS-plus (Model 1 or 3?)	$100
Percom Doubler	$165
LNW dbl. density, DOS-plus	$175
DoubleZAP-II/80 patch	$47.45
PMC-80 16k computer	$610
PMC-80 expansion (S-100)	$380
32k S-100 RAM card	$270
Percom 40-track drive	$375
Epson MX-80 printer	$525
Centronics 737 printer	$850
Starwriter 25cps daisywheel	$1,610
Anadex DP9500 200cps	$1,525
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s...notices...n

Popular Computing Is Popular

Speaking of other magazines, you may have noticed the banner on several covers, "Now including Popular Computing." In March 1980, we purchased the TRS-80-oriented *Popular Computing Newsletter*. Originally, we intended to run a TRS-80 section in *Creative Computing* called "Popular Computing." However, that seemed somewhat narrow so when Chas. Andres proposed a regular cartoon strip to us, we decided to use the Popular Computing name on it. Chas. Andres, incidentally, is the author of the computer cult cartoon book, *CPU Wars*, a marvelous Adventure-type war between DEC and IBM.

Some four months ago McGraw-Hill's *Byte* subsidiary bought a different *Popular Computing* newsletter/magazine. They plan to change the name of *onComputing* to *Popular Computing* in November and increase the frequency from quarterly to monthly. As is their way, they have taken legal action to prevent us from further use of the name.

To muddy the waters still further, CW Communications, publishers of *Computerworld* and *Inforworld*, also lay claim to the name "Popular Computing." They filed for a trademark well over a year ago.

Who really owns "Popular Computing?" Only time and the courts will tell.

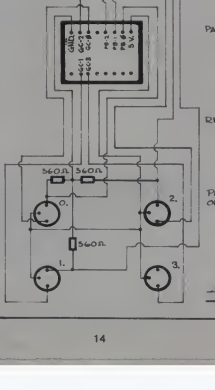
Corrections

There is a mistake in our response to the Hunter High School Computer Room on page 11 of the June issue. For the new PET, POKE 144,88 works better.

Honeywell Correction

Our Buyer's Guide to Small Business Computers (May, 1981) contained incorrect information concerning the Honeywell Level 6 Model 23. The correct information is printed below.

Basic CPU	$6460
Diskette Adapter	1260
256-K Byte Diskette	1785
1 Work Station	1500
Work Station Adapter	525
GCOS 6 MOD200	2090
TOTAL	$13,620



The wiring diagram from "Tero's Apple" (May 1981) lacked two lines. They are shown in the diagram.

TIRED OF WAITING?

Frustrating isn't it! No matter how much you speed up your program it still seems to take forever to save data onto a cassette. Wouldn't it be great if someone could design a mass storage system with the speed of a disk, but at half the cost? *Exatron* did, the *Exatron Stringy Floppy (ESF)*.

Totally self-contained, the ESF is an extremely fast, reliable, and economical alternative to cassette or disk storage of programs or data. All of the ESF's functions are under the computer's control, with no buttons, switches, knobs or levers to adjust or forget.

The ESF uses a miniature tape cartridge, about the size of a business card, called a *wafer*. The transport mechanism has a direct drive motor with only one moving part. Designed to read and write digital data only, the ESF suffers from none of the drawbacks of cassettes - without the expense of disks.

Several versions of the ESF are available, for the *TRS-80, Apple, PET, OSI* and an *RS 232* unit. Even the slowest of the units is 15 times faster than a cassette, and all are as reliable as disk drives - in fact in some cases they are more reliable.

exatron

To get further information about the ESF give Exatron a call at their Hot Line *800-538-8559* (inside California 408-737-7111).

If you can't wait any longer then take advantage of their 30 day money-back guarantee - you've nothing to lose but time!

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At Hayes, we've been making high-end (and high-priced) modems for years. We believe in taking the state of the art to the limit. Our new Smartmodem Network Stack is the most sophisticated, high-fraud programmable answer modem you can buy. And yet it's perhaps the easiest to use modem ever.

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Smartmodem also includes several switch-selectable features that let you tailor performance to your exact needs. You can set it and forget it for the ultimate in convenience.

Built-in Audio Monitor. Thanks to an internal speaker, you can actually listen to your connection being made. You'll know immediately if the line is busy or if you reached a wrong number — *and you don't even need a phone.*

Status at a Glance. Seven LEDs indicate Smartmodem's current operating mode, and whether communication link has been established. Your modem never leaves you in the dark.

Direct-Connect Design. Smartmodem is FCC registered for direct connection to any modular phone jack. There's no acoustic coupler to worry about, and it won't pick up noise.

Smartmodem, Smart Buy. Professional quality features. Yet at a performance. A full two-year limited warranty. And suggested retail price of only $249.

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The Prince and the Paper

Keith E. Walker

You pays your money and you takes your chances, they say, and sooner or later you'll probably take your chances on a printer. This review will cover the Silentype printer by Apple Computer and a software package offered by Computer Station for this printer. The software package is also available for the Paper Tiger printers hooked up to an Apple II.

The Silentype printer is offered by Apple Computer for the Apple II and the new Apple III computers. The printer comes with its own special interface card and one roll of paper, which by the way, comes in 80' rolls and is 8.5" wide.

Now, I'm just a computer hacker who enjoys punching out totally incomprehensible programs that only another hacker could love. But, deep in the heart of all hackers is a yearning to write THE program that everyone simply has to have.

A printer may not help me become a better programmer, but it couldn't hurt. No more nights spent LISTing and LISTing and LISTing. Hard Copy! Just the sound of those words brings warmth to my heart.

The main reason I wanted a printer was for programming, so a letter-quality printer wasn't necessary (or affordable) and indelible copy wasn't needed. So I chose the Silentype. It is the third printer in Apple's lineup and it retails for $625 (or whatever you and your friendly merchant agree upon. Don't tell anyone, but I got mine for a *lot* less).

The printer buzzes along at the breathtaking speed of 40 characters per second (top speed) and prints those letters in a 5 x 7 dot matrix. The speed varies, though, with how dark the intensity is set. The darker the type, the slower the printing speed and vice versa.

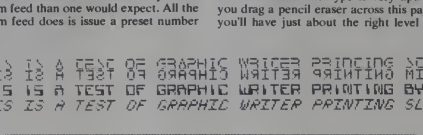
It handles the normal ASCII character set (without true descenders on lower case), and prints in both uni-directional and bi-directional formats. The maximum line length is 84 characters with 10 characters to the inch. The Silentype has the standard six lines per inch vertical spacing.

Completely devoid of any buttons or switches (inside or out), the only control on the printer is a typewriter-like platen feed. Just one little knob to worry about. All of the controls are handled with software or by directly accessing printer memory (via POKEs or control characters). This means never having to remove the cover to get at DIP switches.

As for control characters, the Silentype recognizes LF and FF (line feed and form feed) but reacts a little differently to the form feed than one would expect. All the form feed does is issue a preset number of line feeds. With non-perforated roll type paper, a true form feed doesn't make much sense anyway. The operator can vary the number of line feeds it does by POKEing a certain address.

The other control characters handle such features as graphics screen dump, printer/CRT mirroring (this limits the printer to 40 letters per line due to the Apple screen width) and a normal 80 character width output.

What about print quality and that doggone thermal paper? Well, print quality is as good as the the average impact printer and this printer won't wake up the cat. The name Silentype is very apt. If you drag a pencil eraser across this page you'll have just about the right level of


THIS IS A TEST OF GRAPHIC WRITER PRINTING SLANT
THIS IS A TEST OF GRAPHIC WRITER PRINTING BYTE
THIS IS A TEST OF GRAPHIC WRITER PRINTING MIRROR

Keith E. Walker, 726 5th Ave. So., Apt A, Great Falls, MT 59405.

```
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noise. In other words, it is very, very quiet.

Contrary to what you may have heard, the Silentype doesn't use that weird feeling, scratch prone, silver paper that thermal printers used to use, but a white paper that is almost indistinguishable from the real thing.

While it is true that if you like to keep your paper in the oven or in the trunk of your car when you're not using it, the paper will turn black, but it just isn't as sensitive to heat as everyone makes it sound. The technology of paper seems to have kept pace with the rest of the microcomputer industry.

I have many list-outs that are approaching their first birthday, and there is no deterioration . . . yet. Another difficulty is trying to get something resembling a standard size sheet of paper when you have to decide where to tear the sheet (no dotted lines here!).

One more thing the Silentype doesn't offer is the extended type fonts (stretched out letters) that true impact printers offer. Those characters are great for headers and form printing.

The graphics capabilities are about average for a modern printer, but you don't have to purchase special graphics software to use it. All that you have to do is press ctrl-Q, stand back and watch. If you don't mind a little inaccuracy the Silentype will do the graphics dump bi-directionally which is pretty quick, or for a better look, you can set the printer for uni-directional printing, which isn't very fast.

Altogether, I'm very pleased with the Silentype printer, except for one very small detail. For those people lucky enough to own an Apple III computer, the Silentype can be programmed to print different fonts. Seems as though Apple could have at least offered that proper software for the Apple II.

But, where there's a need, there's a programmer, and Computer Station in St. Louis, MO, offers software to accomplish this feat. The only requirement for this software package is that you have DOS 3.3 and Apple DOS Tool Kit. Known as "Graphic Writer," it will print any of the fonts available in the DOS Took Kit (about 30 different ones), with the only limitation being that you can only print 69 letters to the lines as opposed to the normal 80. But don't be alarmed, the characters still spread fully across the page. The routine is pretty easy to incorporate into your programs and is compatible with Apple Writer (in fact, it was designed for it).

To include Graphic Writer in a program of your own, Computer Station has provided an example program. It explains with REMarks how to accomplish the task. All it involves is loading in the object code and your chosen character set and doing a few pokes to initialize the program. Computer Station didn't exactly go overboard in providing information on how the object code works, but then how many companies do?

All in all, Graphic Writer has to be one of the best things that has happened to the Silentype. With it, you can print in anything from ASCII to Katakana (Japanese characters), or even special graphics characters. And as a plus you now get true descenders on your lower case letters. Quite an impressive package.

To sum things up, I am very pleased with the Silentype printer, especially in combination with the Graphic Writer package from Computer Station. While it's true that my print-outs will get a tan if I leave them out in the sun for too long, this is a small problem to overcome. The print quality is good, the speed isn't bad and it *is* quiet. Graphic dumps are as easy as pie with control from within a program fairly easy to accomplish.

I'll give it an 85, it's got a good beat and it's easy to dance to. □

POPULAR COMPUTING

Chas Andres

WOW! THAT VLSI CHIP, W/8 CAN DO 80 OPS!
VLSI?!? YOU COMPUTER GEEPS EVEN HAVE YOUR OWN LANGUAGE! NOW DO YOU EXPECT ME TO UNDERSTAND YOU?
'VLSI' MEANS "VERY LARGE SCALE INTEGRATION!"
IN THIS NEIGHBORHOOD?! ARE YOU CRAZY?!?
SHOULD WE TELL HIM?
NO - JUST DON'T MAKE ANY REFERENCE TO FEMALE CONNECTORS OR MOTHER BOARDS.
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The BEST games are from Creative Computing Software

1978: Adventure
1979: Air Traffic Controller
1980: Super Invader
1981: Blister Ball and Mad Bomber

Blister Ball

Blister Ball is the first completely original arcade-type game for a computer. Not a copy, not an adaptation, not a spinoff. **Blister Ball** is new—it's a new idea—better than Invaders, better than Circus, better than Asteroids, better than Galaxian. If you've played other games for hours, you'll play **Blister Ball** for days.

How does it work? Well, some mean but fun-loving aliens have produced some bouncing bombs. First they drop one and you've got to position yourself under it and zap it with your laser. If you miss, that's OK. It will bounce around, although each bounce is lower, and you have several chances to zap it. Got the hang of it? OK, here come two bouncing bombs. You zap them. Then you're faced with three, then four and five.

As they bounce longer and longer the walls begin to close in so you're faced with either zapping the bombs or being hit. Each hit knocks you a little further toward the gutter. But you can survive two hits which is usually enough to zap all the bombs.

Feeling confident? Don't. Because after 5 bombs the murderous little devils drop 5 bonus bombs, worth ten times as much. These don't bounce, so you get only one shot. You need nerves of steel and the reflexes of a tail gunner.

After you complete one round,the game starts again with bombs that bounce faster and lower (and are worth more) than the previous ones.

Blister Ball is a fantastic solo game. But there are two-player options as well in which players can play as a team or as opponents. Each player can move the entire width of the screen and zap any of the bombs. Here, you're not only trying to survive, but trying to outscore your opponent. The game has two skill levels.

Mad Bomber

In **Mad Bomber** you are faced with aliens in a huge ship hovering overhead. They have bomb racks which they constantly fill with bombs. Your object is to move from side to side on the ground and zap the bombs in the bomb racks or as they fall.

As the game progresses, the aliens fill up their bomb racks more quickly and the bombs fall faster. You lose after ten bombs have hit the area which you are defending.

Mad Bomber can be played by one player solo or by two players as a team or as opponents. Two skill levels.

Order Today

Blister Ball and **Mad Bomber** are available together for $29.95 on disk (DOS 3.2) only and require a 48K Apple with paddle controls. (We recommend using the Super Paddles from Peripherals Plus).

To order send $29.95 plus $2.00 shipping and handling to the address below. Credit card customers should include card number and expiration date of Visa, MasterCard or American Express card. Credit card orders may also be called in to our toll-free number in the continental U.S.

If you also wish to order a set of Super Paddles from our Peripherals Plus subsidiary, the cost is just $39.95. The paddles are backed by a 90-day limited warranty from the manufacturer as well as Peripherals Plus' moneyback guarantee of satisfaction.

Blister Ball and **Mad Bomber** are colorful, challenging, fast and noisy. They are the games of the year from Sensational Software.

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Pegging for More

Dale Archibald

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SOFTWARE PROFILE

Name: Hi-Res Cribbage

Type: Cardgame

System: 48K Apple II or II Plus and one disk drive. DOS 3.2 and 3.3

Format: Graphics

Language: Machine

Summary: Spare-time diversion for avid cribbage fans

Price: $24.95

Manufacturer:
On-Line Systems
36575 Mudge Ranch Rd.
Coarsegold, CA 93614

The Hi-Res Cribbage game designed by Warren Schwader for On-Line Systems has fine graphics and plays a mean hand. For a beginner, it would be a good way to learn. An expert might want to practice cribbage skills with various hands.

The program deals two hands of six cards. It lays the player's hand face up. You select which two cards you want to place in the crib (discard pile for a later count). When you've done so, the computer discards two and play begins.

For non-cribbage players, let me explain that one object during the play of the hand is to play a card that brings the running total to 15 or 31. This earns points for the player and advances the peg the correct number on the well-drawn cribbage board. (The noise made as the peg is advanced gets a bit irritating, I felt.) Other scoring configurations, such as pairs, triplets, or a run, also advance the peg. Once all cards from the hand have been played, the program outlines the scoring combinations held in the hand.

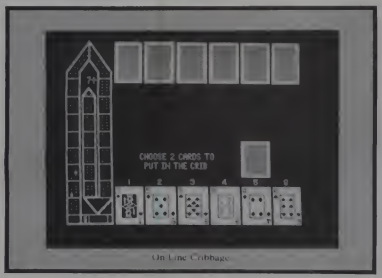
A jack and a five, for instance, totals 15 and receives two points. Two jacks and a five earn two points twice, and two for the pair. The program lists the number of pairs, fifteens, etc., and advances the peg the correct number. After both hands have been played, the program totals the points in the crib and advances the peg for them.

The beginner's game holds the list of combinations and points received quite a long time to allow the novice to see how the sums are arrived at. For an intermediate cribbage player such as I, they were held much too long.

The advanced game, on the other hand, plays much too fast, and sweeps the played cards away so rapidly that there's almost no chance to see what was played...and I'm a speed reader.

A game may be saved in mid-play if you have a disk prepared by Hi-Res Cribbage. I'd like to take this opportunity to complain about this practice; why do so many software publishers demand a disk initialized by each particular program? It means a blank disk saved just for that particular game or whatever, and I'm unwilling to spend that much money just to save one unfinished item. Why can't they do as Strategic Simulations does? You can save their games on any initialized disk.

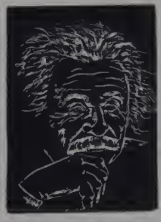
Be that as it may, this is a good cribbage learning tool, and the instruction book is very clear and explanatory. If you're in need of an everready partner here 'tis. □



On-Line Cribbage

Dale Archibald, 1817 Third Ave. N., Minneapolis, MN 55405.

An Intelligent Alternative



TYPRINTER 221

In the research you are doing before purchasing your computer printer, you are probably confused by the various claims, speeds, choices, shapes and prices. Well, we'd like to clear the air a bit and tell you about the most unusual computer-printer around — the TYPRINTER 221.

You see, it's unusual because it is **totally compatible** with every computer and word processing program . . . from the largest to the smallest. It's versatile to the point of incredibility. We'll discuss the broad advanteges and explain the details.

THE DAISY WHEEL

The special daisy wheel supplied as of a unique design consisting of a 100 character carrying radii. Each radii is formed of two distinct types of plastic — an "elastic plastic" for the stalk of the radii, and a comparatively "hard plastic" used to form the character area. This, combined with a very narrow character profile end a special positioner on each of the 100 radii, guarantees a uniform character density. There is near perfect geometric positioning of the character with no character higher or lower than the others. And because of its unique dual material design, microvibrations have virtually been eliminated, leaving your final copy clean, clear and smudge free. The copy produced is comparable to that produced by metal daisy wheels and at a fraction of the cost.

THE KEYBOARD

The keyboard has been referred to as a triumph of human engineering - from the way the keys seem to have been custom designed to fit your fingers, to the way the special feature switches have been grouped. A flip of a switch (or under computer control of course) and the printer becomes a foreign language machine. Push a button, and like magic the printer automatically locates and lines up columns of figures, perfectly balanced between the margins. This incredibly fast, extraordinarily quiet electronic keyboard puts more programming power at you fingertips then printers costing five to ten times as much.

THE DISPLAY

The TYPRINTER 221 presents a new dimension in operator/machine communications. In the manual (typewriter) mode, the printer controls and verifies all entries before printing. The display exhibits the last 15 characters of the text, word-by-word, until the end of the line. The operator may control what will be printed before the actual printing takes place. This new found flexibility enables you to make modifications along the entire line and in both directions. This 20 character plasma display has the ability to scroll backwards as well as forwards, will give the operator a visual indication as to which print mode is currently being selected as well as the number of characters remaining before the right margin is reached. The display will also indicate to the operator:

- The number of characters available in the memory
- When the printer is in an error condition
- When a pre programmed form lay out has been selected
- When the printer is operating from the internal memory
- When characters will be inserted into an existing text
- When the memory for the previous line has been selected
- A warning message that the end of the page is being approached
- That a hyphenation decision must be made

PRINT MODE

The TYPRINTER 221 will allow you to automatically highlight individual characters, words or complete sentences. Whatever is entered from the keyboard or from the computer, even an existing text file, can be printed in one or more of the five different modes:

- traditional printing;
- underlined chercters;
- true bold characters where the horizontal component of the character is increased without disturbing the vertical component;
- characters which are both bold and underlined, and;
- a feature unique among computer printers- printing in reverse — white on black, sort of reverse video on paper.

MULTILINGUAL CAPABILITY

A unique and useful feature of the TYPRINTER 221 is its capability of being able to print in several languages without changing the daisy wheel. In addition to English, every standerd daisy wheel has the ability and the necessary characters to print in French, Spanish, Italian and German.

CIRCLE 190 ON READER SERVICE CARD

THE FEATURES

Automatic justification of the right margin

The electronics of the TYPRINTER 221 have made right hand justification a simple, automatic operation

Phrase and formet storage

Phrases dates, addresses, data, etc that may be stored in your computer's memory may be sent over to the printer and stored in one of the "memory bins" of the printer. This information may then be used by the operator in the manuel mode. This can save you hours when trying to get a form "just right."

Autometic centering

The TYPRINTER 221 will not only center any title between the pre-set margins, but will also center over one or more columns, or over any specific point and will even align copy with the right margin independent of the left margin.

Automatic vertical lines

A command from the computer enables an automatic feature which prints vertical lines at any point on the paper.

Automatic tab sequance recall

With the TYPRINTER 221 you may store and recall the most frequently needed margin and tab sequences for applications such as daily correspondence, statistical reports, etc. This guarantees consistent high quality appearance of each document.

Paragraph indent

A computer command instantly sets a temporary margin in order to print one or more indented paragraphs with respect to the right margin.

Automatic decimal point focetion

No matter how many figures to either the left or right of the decimal point, the TYPRINTER 221 will automatically line up the figures with the decimal point in any position you choose. Statistical printing has never been easier.

Column layout

This feature allows you to obtain automatic and perfect distribution of spaces between columns in respect to the margins. A perfect page balance is assured without the need to carry out calculations or additional operations.

There is a wide variety of options that you can add to TYPRINTER 221.

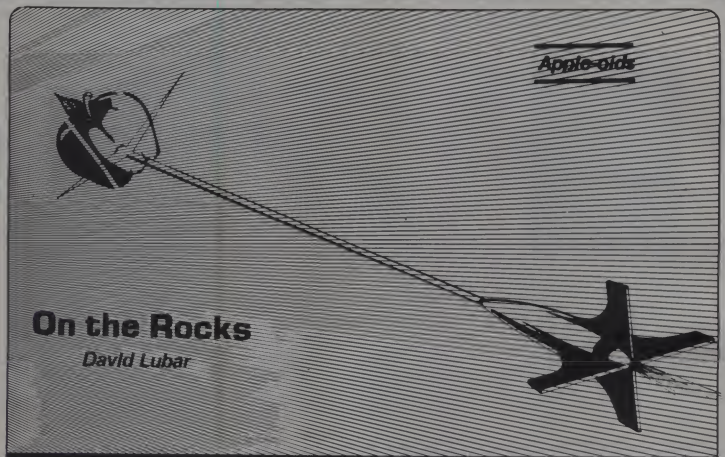
By now you are probably convinced that **we are sold** on our machine, and we hope you can understand why. In fact, why don't you use these facts to measure against any and/or all the other computer printers on the market.

When you do, you will realize the TYPRINTER 221 is an intelligent electronic typewriter, a text formatter — and a brilliant computer printer — available at a suggested list price of only $2850.

TYPRINTER 221 is available at your local computer shop — or we'll tell you where you can see and try one if you call us at

HOWARD INDUSTRIES

2051 E. CERRITOS AVE., 8C
ANAHEIM, CA 92806
714/778-3443



On the Rocks

David Lubar

Ever since Bruce Wallace wrote the Apple version of Asteroids in Space (available from Quality Software), new versions of asteroids have appeared with startling regularity. At least four versions were sent to us in the past year. None was reviewed since none was as good as the original Wallace program. Now, a new asteroids game has appeared. Expecting yet another rehash, I was pleasantly surprised with the program. While *Apple-oids*, from **California Pacific**, is basically another version of the familiar arcade game, the program has nice touches and additions that make it worth owning.

The most obvious change is the use of floating apples (the fruit, not the computer) instead of asteroids. The apples, when shot, break up into smaller apples, and these smaller apples break up further when hit. You start out with six large apples. Clear them and you get a field of eight. Each successive field has ten apples.

There are two enemy ships that can appear with alarming frequency. The large ship shoots in a pattern rather than aiming for you. Destroying this ship earns you 200 points. The small ship goes for blood and is worth 1000 points. The point values of the apples vary according to size. You start with three ships, and win an extra ship for each 10,000 points.

So far, this all seems fairly standard. But there is more. One of the problems with Asteroids is the method of controlling the ship. *Apple-oids* seems to have taken a fairly sensible approach. Paddle number 1 controls rotation of the ship. The button on that paddle controls thrust. The ship will keep going after you release the button, but it will also decelerate and stop after a while. Firing is controlled from the keyboard. Any key from 0 to 9 fires a shot.

creative computing
SOFTWARE PROFILE

Name: Apple-oids

Type: Arcade game

System: 32K Apple, Disk Drive

Format: Disk

Language: Machine Language

Summary: Fun to play

Price: $29.95

Manufacturer:
California Pacific Computer Co.
7710 Edgewater Dr.
Oakland, CA 94621

Any other key puts you in hyperspace. There is a chance that the ship will explode on emergence from hyperspace. There is also a chance of emerging from hyperspace right on an asteroid. Such occurences are fatal.

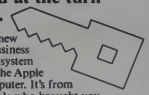
The ship rotates smoothly with a turn of the paddle. When the paddle is at either extreme it sends the ship into a continuous spin. This avoids the problem encountered when the paddle is fully turned and you want to continue rotating.

The game displays the score and high score in hi-res numbers on the side of the screen. The number of ships remaining is represented pictorially at the bottom.

As a bonus, the disk also contains *Chipout*, which, as you've surely guessed, is a version of breakout. Done in hi-res, the program will satisfy breakout fans. There is one very nice touch. You start out with five balls. They are stored in a horizontal slot on the left wall. Each time a new ball comes into play, it slides from the slot, moves across the screen, then drops.

Simply put, *Apple-oids* is very good. The game is fun, highly replayable, and excellent graphically. California Pacific has come out with another winner. □

The business information you need at the turn of a key.



Datadex is a new interactive business management system designed for the Apple personal computer. It's from IUS, the people who brought you EasyWriter™ and who are bringing you new products for office automation, education, and development systems.

Datadex is short for **data index.** It lets you put all your business data into your Apple the way you like to see it and manipulate it any way you want. **It adapts to your way of doing business.**

Want to generate a sales report? Just press four keys and fill in the blanks. That puts your sales data into the computer. Now, your report: Datadex **designs** it **for you,** based on what you've entered. Nothing to it. That's **power!**

You can do the same with phone lists, mailing lists, dealer names or inventories.

They all enter Datadex and form your own personal **data base.**

Want to find a company but don't know how to spell its name? Try something that sounds close, and our **Soundex** routine will find it. It is very forgiving on typos and extra spaces.

Soundex helped us find Mr. Zukrzawski when we were balancing our checkbook. We weren't sure how to spell Al's name, so searched for Al Z and found him. Instantly. The check register and several other applications are free with Datadex.

Want a specific piece of information, like sales for January 14–21? Inquire Datadex and the answer comes up on the screen right now. And right.

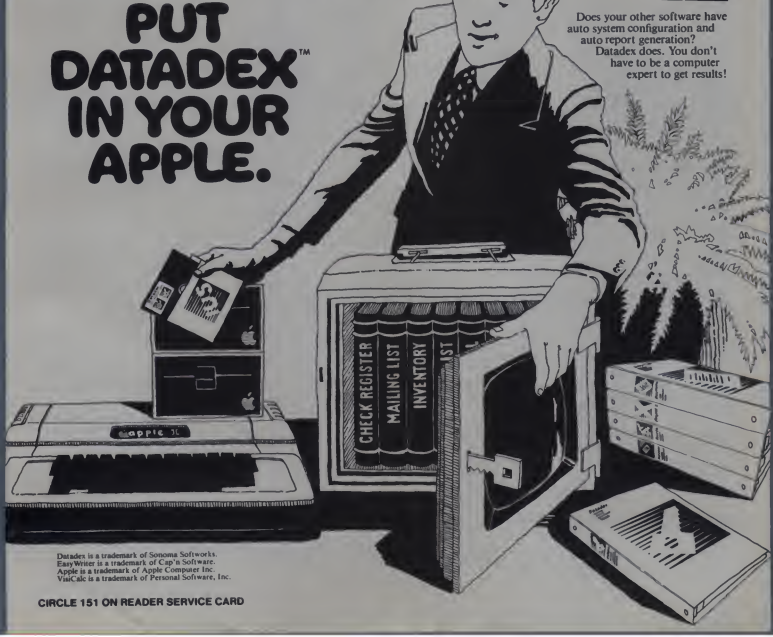
Want a report of all sales in ZIP code areas starting with 9? Sure. Just ask it to print a report.

But seeing is the only way to believe. Get a demonstration of Datadex at your local Apple dealer. See the personal computing power it can bring to your office and home. If you've looked at a VisiCalc-type program, see Datadex before you buy.

By the way, about IUS. We're the Apple of software. We got there by giving you great products and super support. We provide customer service over the phone. Professionally written documentation. And products that are never outdated, only updated. Information Unlimited Software, Incorporated, 281 Arlington Ave., Berkeley, CA 94707. (415) 525-9452.

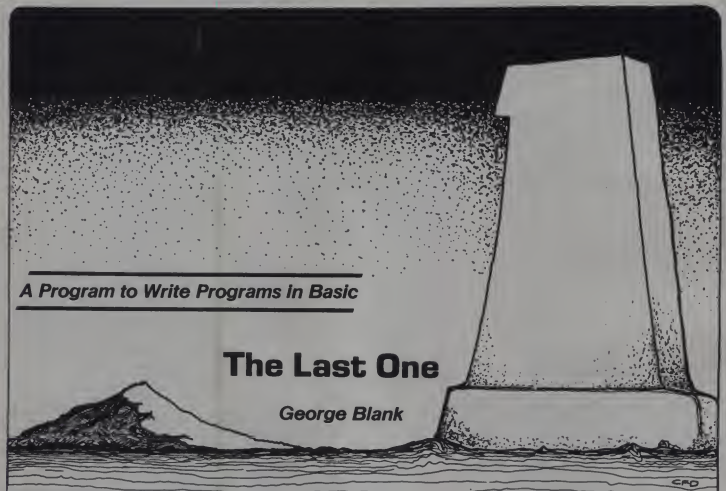
Does your other software have auto system configuration and auto report generation? Datadex does. You don't have to be a computer expert to get results!

PUT DATADEX™ IN YOUR APPLE.



Datadex is a trademark of Sonoma Softworks.
EasyWriter is a trademark of Cap'n Software.
Apple is a trademark of Apple Computer Inc.
VisiCalc is a trademark of Personal Software, Inc.

CIRCLE 151 ON READER SERVICE CARD



A Program to Write Programs In Basic

The Last One

George Blank

creative computing
SOFTWARE PROFILE

Name: The Last One

Type: Programming Tool

System: 48K Apple, CBM, Atari, TRS-80, OSI, Sharp

Format: Disk

Language: Creates Basic programs

Summary: Potentially great, but unproven

Price: $600 (Tentative)

Manufacturer: D. J. "AI" Systems Ltd.
Station Road,
Ilminster
Somerset, England

This program, currently running in prototype form on Ohio Scientific C-3 computers, writes computer programs in Basic. Its name, "The Last One," is meant to imply that human beings will no longer have to write programs. I fear that the authors are excessively optimistic, but the program does work, and is a significant advance in programming.

The operator answers questions from menus presented on the computer screen.

```
1 Open Files 1—2
2 Jump to end of file 2
3 Set index to start of file 1
4 Console input using labels from file 2
5 Ask user "Is this data correct". If no jump
6 Search file 1 for data
```

Figure 1. Sample Pseudo Code.

Then the program translates the answers to these questions into pseudocode as in the figure. Finally, the pseudocode is compiled into a standard Basic program. The program is well commented, with the pseudocode listed in remark statements when memory allows. Since the finished product is in ordinary Basic, it can be edited and modified.

The demonstration of the prototype was under controlled conditions, with all operation by the author of the program and no opportunity for lesser mortals to try it. This would make it easy for the author to avoid problems the program couldn't handle. Despite this, it was easy to see that The Last One could be a significant aid in rapidly developing an error free Basic program.

At least in the current implementation, the program requires a programmer to operate it. It is necessary to anticipate the file structure and organize the development of the program in a logical order. While this requires skill and planning, it is much faster than typing the code by hand, and no debugging time seemed to be necessary.

The principals of the firm, David James (the programmer) and 'Scotty' Bambury, anticipate having the program ready by late summer. Versions are planned for Ohio Scientific, Apple, Atari, TRS-80, PET and Sharp computer systems, with a projected price of $600. James and Bambury expect eventually to extend The Last One to program in other languages, with Cobol to be implemented next.

No graphics abilities were demonstrated, and it is likely to be a long time before clever graphics programmers become obsolete. The logical conclusion is that The Last One is useful primarily for straightforward business and computational applications. This reviewer feels that many such applications can probably be done faster, better, and easier with VisiCalc, making it unnecessary to write a program in the first place. Because The Last One generates Basic code, it necessarily shares the limitations of Basic, including slow speed, somewhat clumsy structure, and inefficient use of memory.

Creative Computing will publish an in-depth review when a version is ready for release. □

ALL THE PROGRAMS YOU'LL EVER NEED.

FOR $600.

Say goodbye to the costs and frustrations associated with writing software: The Last One® will be available very soon.

More comprehensive and advanced than anything else in existence, The Last One® is a computer program that writes computer programs. Programs that work first time, every time.

By asking you questions in *genuinely* plain English about what you want your program to do, The Last One® uses those answers to generate a totally bug-free program in BASIC, ready to put to immediate use.

What's more, with The Last One,® you can change or modify your programs as often as you wish. Without effort, fuss or any additional cost. So as your requirements change, your programs can too.

In fact, it's the end of programming as you know it.

And if, because of the difficulties and costs of buying, writing and customising software, you've put off purchasing a computer system up to now, you need delay no longer.

The Last One® will be available very soon from better computer outlets. To place your order, take this ad into your local dealer and ask him for further details. Or in case of difficulty, please write to us direct.

THE LAST ONE®

YOU'LL NEVER NEED BUY ANOTHER PROGRAM.
D.J. 'AI' Systems Ltd., Ilminster, Somerset, TA19 9BQ. England
Telephone: 04605 - 4117. Telex: 46338 ANYTYR G.

CIRCLE 134 ON READER SERVICE CARD

creative computing software evaluation

TI 99/4 Music Maker Module

Deep in the Heart of Texas

Owen Linderholm

From deep in the heart of Texas comes the Music Module, a plug-in module for the TI 99/4 which gives it limited music synthesis capability. No fancy sixteen voice, waveform controlled or stereo output machine, the module provides only three music voices, some volume control and a little bit of noise generation.

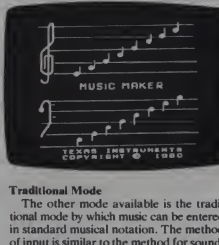
Sound-Graphs

Two modes are available: "sound-graphs" and "traditional," the first is used mainly as a strange noise maker. When you enter this mode you are asked which noise generator you want, what speed at which to play the music and whether you want to change any of the frequencies for the scales. There are eight noise generators available, four of which provide "periodic" noise and four of which provide "white" noise. One generator from each of these two groups plays noise based on the frequency of the third musical voice. When I was experimenting with these generators, I found that they added very little to the sound produced. Of the speeds available, only those between about 15 and 30 were of much use, as those lower than 15 were far too slow to play the music in a recognizable manner.

The ability to change frequencies is of some use, but since the sound-graph mode cannot produce much of musical value this feature is not very useful.

When these values have been set, the computer proceeds to the music input mode. The user is shown two rectangular areas in which he can draw lines which represent various frequencies, volumes and noises. Inputting a measure can be done with the keyboard or the Wired Remote Controllers. I found the keyboard very awkward to use and could only input exactly what I wanted with difficulty.

Editing of the music already entered can be easy or difficult depending on how much needs to be changed and on where and when the mistake is discovered. One very useful editing facility is the ability to copy all or part of a measure already entered. Playback of the music is relatively simple and pleasant effects are obtainable with a little effort. The longest composition can only be 46 measures, which is generally long enough for most purposes but can be annoying if a longer piece is desired.



Traditional Mode

The other mode available is the traditional mode by which music can be entered in standard musical notation. The method of input is similar to the method for sound-graphs. When you enter the traditional mode, you are asked to enter the number of sharps or flats to define the key signature, then the time signature and the speed. All these are necessary and work as they should, except for the speed which is exactly the same here as for the sound-graphs.

The method of entering music is also the same except that when you wish to change between different types of note, such as between crotchets or quavers, the cursor must be moved from the staff off to the side, where the notes can be changed. This involves a great deal of key pushing and frustration, and makes the entry of most pieces of music a very laborious task.

The staff and the rest of the screen display is very well laid out and the music is easy to read with the three different voices shown in three separate colors. Another feature is that each note can have independent volume control on a scale of one to eight. This allows crescendos and decrescendos and so on, but is also a bit difficult to use.

Editing and playback are similar to the sound-graph mode and are reasonably straightforward. Music can be easily stored on cassette or disk and retrieved. It is also possible to print out music if the TI thermal printer is connected. These are very useful functions and not available on many more expensive and complicated computer music synthesizers. The other major disadvantage of the module is its three-octave range.

Now comes the great advantage of the Music Maker Module: the extremely low price of $40. At that price, the Music Module is a worthwhile investment for the average user who is not thinking of recording contracts or playing at major concert halls. It is also quite possible that using the remote controllers makes the entry of music a lot simpler. □

Software for the Apple II and Apple II Plus*

BENEATH APPLE DOS
A Technical Manual
By Don Worth and Pieter Lechner

Become an expert on the intricacies of Apple's DOS (Disk Operating System) BENEATH APPLE DOS is the perfect companion to Apple's DOS 3.3 Manual. Containing eight chapters, three appendices, a glossary, an index, and over 160 pages, this manual will serve to completely fill in the many gaps left by Apple's DOS 3.3 Manual. Written for Apple users with DOS 3.3, 3.2 or earlier versions, any Apple disk user would welcome having this carefully written manual at his fingertips

LEARN

- How DOS 3.3 differs from other DOS versions
- How disks are protected
- How to reconstruct a damaged diskette CATALOG
- How tracks are formatted
- How to use the disk directly, *without* DOS
- How to call DOS's file manager
- How every routine in DOS works
- How to customize DOS to your needs
- How to overcome DISK I/O ERRORS
- About the "secret" file types — S and R

INCLUDES

- Large quantities of excellent diagrams and tables
- Source listings of useful disk utilities
- Glossary of over 150 technical terms
- Exhaustive description of DOS program logic
- Handy reference card
- Useful patches to DOS
- Many programming examples

Book - $19.95

CROSS-REF by Jim Aalto

Applesoft programmers will be delighted to have this cross reference utility program in their tool kit of software aids. What can CROSS-REF do to speed and facilitate your Applesoft program development? Consider these functions

VARIABLE CROSS REFERENCE	LINE CROSS REFERENCE
FIND VARIABLE	FIND LINE NUMBER
REPLACE VARIABLE	VARIABLE ONLY LISTING
	LINE ONLY LISTING

Features that make CROSS REF easy to use include

- Written in machine language, occupies less than 3K
- Resides passively in memory while DOS or Applesoft is active
- Can be loaded with your Applesoft program already resident
- Very fast — a VARIABLE CROSS REFERENCE for a 16K Applesoft program can start printing in 5 seconds
- Contains printer format controls and headers for documentation
- Prints English language error messages

Cassette - $22.95 Diskette $24.95

LINKER by Don Worth

Turn your Apple II or Apple II Plus into a powerful and productive software development machine with this superb linking loader/editor package. LINKER does the following and much more

- Dynamically loads and relocates suitably prepared machine language programs anywhere in RAM
- Combines a main program with subroutines. You can assemble a subroutine once and then use it with as many main programs as you wish
- Produces a map of all loaded routines, giving their location and the total length of the resulting module
- Contains a library of subroutines including binary multiplication and division, print text strings, delay, tone generator, and random number generator

Linker works with virtually any assembler for the Apple II. Requires 32K of RAM and one disk drive.

Diskette - $49.95
Manual Only - $19.95

FASTGAMMON™ By Bob Chrisbansen.

Sound, hi res, color, and musical cartoons have helped make this the most popular backgammon playing game for the Apple II. But don't let these entertaining features fool you — FASTGAMMON plays serious backgammon. Runs on any Apple II with at least 24K of RAM.

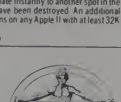
Cassette - $19.95 Diskette - $24.95

METEOROIDS IN SPACE™
By Bruce Wallace

We have taken our popular space game, formerly called Asteroids in Space, and made some important improvements. To accent these improvements we have given it a new name — METEOROIDS IN SPACE. Your space ship travels through a shower of deadly meteoroids. If your ship is hit, it will be destroyed, so you use your laser gun to blast the meteoroids. Big meteoroids shatter into smaller meteoroids when hit, and the smaller ones are usually faster and just as deadly. From time to time you will encounter an alien space ship whose mission is to destroy you, so you'd better destroy it first. All the action is displayed in fast, smooth, high resolution graphics, accompanied by sound effects. You now can control your ship using one of two options — the Apple game paddles or the keyboard. One of the game paddle buttons controls the laser fire. In METEOROIDS IN SPACE, the spaceship's velocity gradually decreases unless more thrust is applied, adding an element of control. Also new to this version is a hyperspace feature — translate instantly to another spot on the galaxy. The game is over when five of your ships have been destroyed. An additional ship is added for every 10,000 points you score. Runs on any Apple II with at least 32K of RAM and one disk drive.

Diskette $19.95

ASTROAPPLE™ by Bob Male



Your Apple computer becomes your astrologer, generating horoscopes and forecasts based on the computed positions of the heavenly bodies. This program offers a delightful and stimulating way to entertain friends. ASTROAPPLE produces natal horoscopes (birth charts) for each person based on his or her birth data. Any two people may be compared for physical, emotional, and intellectual compatibility. The program is written in Applesoft BASIC with machine language subroutines. It requires either RAM or ROM Applesoft and at least 32K of memory.

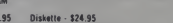
Cassette - $14.95 Diskette - $19.95

FRACAS™ by Stuart Smith

A fantasy adventure game like no other! Up to eight players can participate in FRACAS at the same time. Journey in the land of FAROPH, searching for hidden treasure while warding off all sorts of unfriendly and dangerous creatures. You and your friends can compete with each other or you can join forces and gang up on the monsters. Your location is presented graphically and sound effects enliven the battles. Save your adventure on diskette or cassette and continue it at some other time. Both integer BASIC and Applesoft versions included. Requires at least 32K of RAM.

Cassette - $19.95 Diskette - $24.95

BATTLESHIP COMMANDER™ by Erik Kilk and Matthew Jew



A game of strategy. You and the computer each start out by positioning five ships of different sizes on a ten by ten grid. Then the shooting starts. Place your volleys skillfully — a combination of logic and luck are required to beat the computer. Cartoons show the ships sinking and announce the winner. Sound effects and flashing lights also add to the enjoyment of the game. Both Applesoft and integer BASIC versions are included. Requires at least 32K of RAM.

Cassette - $14.95 Diskette - $19.95

Also by Don Worth

BENEATH APPLE MANOR — Adventure. Uses Integer BASIC
Cassette - $14.95 Diskette - $19.95

BABBLE Fun with words, sound, and graphics
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CIRCLE 195 ON READER SERVICE CARD

The National Computer Conference

Betsy Staples

As I begin this article, my word processor is flanked by 6" stacks of literature describing the new products introduced at the National Computer Conference.

On the top of the pile, the unquestioned leader of the pack, sits the literature on the Xerox Star, "a personal information system for business professionals that combines text editing, graphics creation and communications."

The system consists of a Xerox 8000 NS processor, large size CRT screen, keyboard, disk files and hand-operated pointing device called a "mouse" as well as an internal controller and cable connector for tapping in to the Xerox Ethernet network.

Perhaps the most stunning features of the Star are its graphics and typesetting capabilities. In addition to the standard word and data processing functions you would expect to find on a $16,000 computer, the Star has graphic facilities which enable the user to: draw a line on the screen using the mouse; enlarge or reduce graphics; shade and texture rectangles; join objects in a cluster; split a cluster into several objects; and maintain a library of user-defined graphic symbols.

The Star also has the ability to display a full two pages of typeset material exactly as it will appear when printed-out. Each Star font can consist of over 65,000 different characters. Thus, a single type font could include small caps, accented characters, Greek characters, math symbols, data processing symbols, etc.

The only catch is that the only output device capable of doing justice to these graphics and typesetting features is the $30,000, 12 page per minute, Xerox 8044 electronic printer.

Electronic mail is another area in which the Star shines. When connected to the Ethernet network, incoming mail is depicted on the screen as a letter in the user's in-basket. Any Star document, folder or record file can be "mailed" as is to any number of local and remote network users.

Software options to be offered by Xerox include a package to create complex mathematical equations in correct typeset fashion; a program to check spelling; advanced graphics packages which allow the user to construct automatically table-

The Xerox Star stole the show.

driven bar charts, pie charts and bar graphs; and communications software to enable Star to communicate with non-Xerox workstations.

Rumor has it that by the time you read this Xerox will have introduced a "stripped down" version of the Star in the $6000 price range. We'll let you know as soon as we have more information.

Familiar Faces

Ohio Scientific introduced IBS-NET, a distributed processing computer and local network system with advanced communications capability. Designed for small businesses, individual departments within larger companies, and remote branch offices, the system places microprocessor-based work stations at each key desk in an office and connects them to central disk files, printers and remote communications channels.

A very practical feature of the system is that the end user can start with a stand alone computer system, and as his business grows, add terminals for a time sharing system which can ultimately be networked under IBS-NET, Ohio Scientific, 1333 Chillicothe Rd., Aurora, OH 44202.

Atari announced price reductions for several of its products. The 16K Atari 400 will now retail for $399. Prices of the 8K and 16K RAM Memory Modules for the Atari 800 are now $49.95 and $99.95 respectively, and the Atari 820 40-column impact printer has been reduced to $299.95.

New software available for the Atari 800 includes Personal Financial Management System, a database-oriented system designed to help the user plan and analyze a home budget ($74.95); Dow Jones Investment Evaluator, which connects the computer to the Dow Jones Information Service ($99.95); and Microsoft Basic for the 800 ($89.95).

Atari Sorcim Macro Assembler and Program-Text Editor, both designed for use by advanced programmers were announced with price and availability as yet undetermined. Atari Inc., 1265 Borregas Ave., Sunnyvale, CA 94086.

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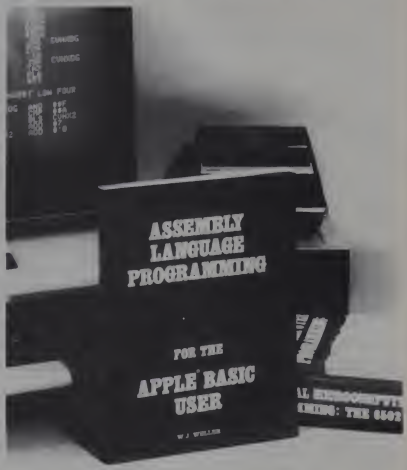

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Commodore was again showing the VIC20, which, it appears, they are actually ready to ship this time.

Scheduled for delivery by Commodore in late 1981 is the Micro-Mainframe, a computer based on the CBM Model 8032 which features an integrated green phosphor 12" (80 x 25) display, 73-key typewriter style keyboard with upper and lower case, numeric keypad and full cursor control.

The Micro-Mainframe is a psuedo 16-bit, 6809-based system with 36K ROM, 96K user RAM and 2K screen RAM, and supports most CBM peripherals.

It can operate as a stand alone system, as a mainframe system development tool using available languages and up-load/off-load capabilities, and for training in language and system design. A software package, designed by Waterloo Computing Systems Limited, includes interpreters for Waterloo MicroBasic, Micro-Pascal, MicroFortran and MicroAPL; a text editor; operating system; and assembly language development system. Commodore, 300 Valley Forge Square, 681 Moore Rd., King of Prussia, PA 19406.

From the Orient

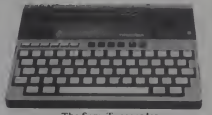
Most of the Japanese firms, being relatively new to the computer industry were relegated to basement level of McCormick Place. Their new products were aimed squarely at the business market.

Toshiba was showing the T200/T250 computer system, which consists of a keyboard; monitor, CPU and disk drive unit; and 136-column, 125 cps, dot matrix printer. The 64K machine features 10 user-programmable function keys and Microsoft Basic-80 running under CP/M. The T200 is available with one or two 5 1/4" disk drives; the T250 with one or two 8" drives. Toshiba Corporation, Tokyo, Japan.

the Toshiba T250.

Sony introduced the Typecorder, a "letter size," portable, electronic typewriter, dictator, transcriber and communicator. The battery-powered unit has a 40-character, single line display which allows typed text to be edited before transmission and/or print out.

It contains a microcassette, which can be used for dictation/transcription or storage of up to 100 pages of text. Available options include the Compact Printer, Office Printer, Electric Typewriter Actuator, Acoustic Coupler Transmitter, Telex Tape Puncher and Communication/Printer Interface.



The Sony Typecorder.

Also new from Sony is the Series 35 "total word processing system" which features a built-in microcassette recorder for dictation and full page CRT display. Text may be stored on dual high density 3.5" micro floppy disks. The Series 35 is compatible with the Typecorder. Sony, Office Products Division, 9 West 57th St., New York, NY 10019.

Sharp Electronics announced the Sharp YX-3200, a desktop system with 32K ROM and 64K RAM expandable to 72K and 128K respectively. It can accommodate up to eight dual-sided, double density, 5 1/4" disk drives.

CP/M compatible, the system features an Automatic Program Generator which allows the user to create programs by answering a series of simple questions. Business applications software is also available.

"...and it will also slice, dice, and make french fries."

A high-resolution, 12" CRT display featuring upper and lower case characters on an 80 x 24 screen, and a bi-direction, dot matrix, 80 cps printer round out the system, which carries a retail price under $6,000.

The Sharp PC-1211 Pocket Computer, also introduced at NCC, boasts 1.9K of RAM programmable through the keyboard. Optional cassette interfaces and printer provide increased storage capacity and hard copy.

The Sharp PC-1211.

The Pocket Computer can handle Basic programs of up to 70 lines. The display is a 24-character, dot matrix LCD panel. The suggested retail price of $249.95 includes three manuals. Sharp Electronics Corporation, 10 Keystone Pl., Paramus, NJ 07652.

Several of the desk top computers being shown by **Canon** reflected their calculator ancestry. The TX-10, TX-15 and TX-25 look more like desktop calculators with letters on their keys than computers. All are 6809-based with 1K of RAM. The TX-10/15 has 8K of ROM and the TX-25 has 16K of ROM and a micro-floppy disk cassette.

The TX series has an alphanumeric fluorescent tube display of 20 or 26 characters and a 26 character per line, dot matrix printer. Programming may be done in Basic or Assembler. The TX-10/15 sells for about $1300, and the TX-25 for $2295.

The Canon CX-1 is a desktop computer that looks like a computer with its 12" (80 x 24) CRT display, mini-floppy disk drives and full size printer. It offers 32K of user RAM and storage capacity of 320K if two double density, double-sided disk drives are used. Retail price of the CX-1 is $4995.

In addition to the Basic and Assembler languages included with the system, the Modular Business Accounting software provides seven interactive applications: sales order processing, accounts receivable, accounts payable, inventory, payroll, job cost and general ledger. The MBA packages retail for about $600 each. Canon USA, Inc., One Canon Plaza, Lake Success, NY 11042.

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L. Gehrig	J. Foxx	W. Stargell	H. Aaron
J. DiMaggio	H. Greenberg	W. Mays	L. Brock
J. Jackson	R. Hornsby	P. Rose	R. Carew
C. Sisler	H. Wilson	O. Cepeda	H. Killebrew
S. Mussal	B. Terry	C. Yazstremski	R. Allen
T. Cobb	M. Mantle	W. McCovey	R. Lefore
W. Mays	H. Aaron	R. Jackson	G. Fisk
C. Young-P	W. Johnson-p	G. Brett	B. Madlock
		R. Guidry-P	T. Seaver-p

Performance is based on the interaction of actual batting and pitching data. Game can be played by one or two players with the computer acting as a second player when desired. Players select rosters and lineups and exercise strategic choices including hit and run, base stealing, pinch hitting, intentional walk, etc. Highly realistic, there are two versions, ALL TIME SUPER STAR BASEBALL, and SUPER STAR BASEBALL featuring players of the present decade. Each includes about 50 players allowing nearly an infinite number of roster and lineup possibilities.

***Both Games $24.95**

SWORD OF ZEDEK

Fight to overthrow Ra, The Master of Evil. In this incredible adventure game, you must confront a host of creatures, natural and supernatural. To liberate the Kingdom, alliances must be forged and treasures sought. Treachery, deceit and witchcraft must be faced in your struggles as you encounter wolves, dwarves, elves, dragons, bears, owls, orcs, giant bats, trolls, etc. Each of the twelve treasures will enhance your power, by making you invisible, invulnerable, more eloquent, more skillful in combat, etc., etc., as you explore the realms of geography, both on the surface and underground. Dungeons, temples, castles, mountains, etc., are all a part of the fantastic world of Ra. Each game is unique in this spectacular and complex world of fantasy. $24.95

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The best of the adventure games. Confronts player with complex decision situations and the demand for real time action. Using the Time Machine, players must face a challenging series of environments that include; The Athens of Pericles, Imperial Rome, Nebuchadnezzar's Babylon, Ikhnaton's Egypt, Jerusalem at the time of the crucifixion, The Crusades, Machiavelli's Italy, the French Revolution, the American Revolution, and the English Civil War. Deal with Hitler's Third Reich, Vikings, etc. At the start of each game players may choose a level of difficulty . . . the more difficult, the greater the time pressure. To succeed you must build alliances and struggle with the ruling powers. Each game is unique.

$24.95

ISAAC NEWTON

Perhaps the most fascinating and valuable educational game ever devised - ISAAC NEWTON challenges the players (1-4) to assemble evidence and discern the underlying "Laws of Nature" that have produced this evidence. ISAAC NEWTON is an inductive game that allows players to intervene actively by proposing experiments to determine if new data conform to the "Laws of Nature" in question. Players may set the level of difficulty from simple to fiendishly complex.

In a classroom setting the instructor may elect to choose "Laws of Nature" in accordance with the complete instruction manual provided.

For insight into some of the basic principles underlying **ISAAC NEWTON** see *Godel, Escher, Bach* by Douglas R. Hofstadter, Chapter XIX and Martin Gardner's "Mathematical Games" column in **Scientific American**, October, 1977 and June, 1959.

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CIRCLE 219 ON READER SERVICE CARD

The Canon TX-25.

The Canon LBP-10 laser printer looks more like a copier than a printer.

Other Entries

Vector Graphic unveiled a shared processor system which allows five workers in the same office to perform word and data processing via individual video display terminals. Known as the 5005 Multi-Share System, the computer is Z80-based and uses a 5M, 5 1/4" Winchester disk, a 630K floppy disk and an error-correcting disk controller.

Software provided with the Vector 5005 includes the CP/M-2 operating system, Scope editor, Raid debugger, ZSM assembler and Microsoft Basic-80. Options are Peachtree business accounting office software, and the Memorite III word processing and ExecuPlan financial planning packages. The system with a single terminal is priced at $8995; additional terminals are $1895 each. Vector Graphic Inc., 31364 Via Colinas, Westlake Village, CA 91362.

Intertec Data Systems also announced a multi-user, shared disk computer system. Each CompuStar Multi-User System consists of a network of up to 255 daisy-chained video display terminals, each of which employs its own internal microprocessor and dynamic RAM.

A CompuStar system can be configured using a 10M Winchester-type drive or a 32M or 96M Control Data Corporation Cartridge Module Drive with a 16M removable, top-loading platter and either 16M or 80M or fixed disk storage. Further flexibility is available through a choice of four types of Video Processing Units. Intertec Data Systems, 2300 Broad River Rd., Columbia, SC 29210.

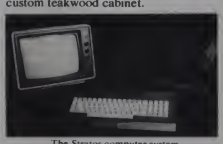
A CompuStar constellation.

The Chieftain 98W30 from **Smoke Signal Broadcasting** is configured around the 6809 microprocessor and has 32K or RAM expandable to 1M.

In addition to a 30M 8" Winchester disk drive, the 98W30 supports an 8" floppy disk drive for 1M of back-up storage and offers a 20M tape streamer option.

Software available for the system includes the OS-9 Level I and Level II multi-user, multi-tasking operating system. The Chieftain 98W30 sells for $9995. Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village, CA 91362.

Symbiotic Systems announced the Stratos computer system, a Z80A-based computer with 80K of dynamic RAM and 1.2M of on-line disk storage enclosed in a custom teakwood cabinet.



The Stratos computer system.

Among the software included with the Stratos are a built-in ROM Monitor, CP/M 2.2, the Spellbinder word processing text editor and office management system, a choice of either CBasic or Pascal compiler, a full financial package, and a program to create new character sets with a light pen. Symbiotic Systems, 118 Naglee Ave., Santa Cruz, CA 95060.

"For the exercise of intelligence, on invention and discovery, a man must have some surplus materials, time, and energy, at his personal disposal, with freedom to seek whatever employment he prefers."
Isabel Paterson

Print It!

A recurring theme throughout the exhibit area was the new and ever trickier printer. Everyone was emphasizing print quality and graphics capabilities.

At the top of the heap here were the laser printers which look like office copiers and produce original copies. Probably because they look like copiers, they seem slow, but when you remember that the real comparison is to be made with other letter-quality printers, 10 pages per minute doesn't seem so bad.

The **Canon** LBP-10, an OEM product, uses plain paper and offers vertical or horizontal print selection. A font selection feature allows the user to print using proportional spacing or boldface type. Optional interfaces include 8-bit parallel and RS-232C serial. LBP Department, Canon USA, One Canon Plaza, Lake Success, NY 11042.

The Imprint-10, based on the Canon LBP-10, is a xerographic intelligent printer system which uses software definable fonts to print justified text in a variety of styles and sizes. It also prints on plain paper and comes with a standard RS-232 interface. Pricing on the Imprint-10 is "in the upper $20,000 range." Imagen, 12769 Dianne Dr., Los Altos Hills, CA 94022.

Another printer making use of advanced technology was the AJ650, an ink-jet printer from Anderson Jacobson Inc. Character width and spacing are variable and can be switched from 80 characters per line to a compressed 132 characters per line. Under computer control, it will print extended characters, boldface and upper and lower case in any combination at a speed of 180 or 210 cps. A disposable ink cartridge supplies ink to the print head. Price of the AJ650 is $3500. Anderson Jacobson Inc., 521 Charcot Ave., San Jose, CA 95131.

Dot Matrix Printers

Based on the print quality being delivered by many of the dot matrix printers at NCC, we can no longer draw a line between dot matrix and letter-quality printers.

The **Toshiba** TH-2100H, for example, is a dot matrix printer with a 24 thin-wire

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NCC, continued...

head whose print quality is all but unidentifiable as dot matrix. It features proportional spacing and graphics, and prints at 100 cps for word processing and 160 cps for data processing. The TH-2100H is currently

100 CPS FOR WORD PROCE

160 CPS FOR DATA PROCES

24xN FOR WORD PROCESSI

Print sample: Toshiba TH-2100H.

available only to OEMs at a price under $2000. Toshiba America, Inc., OEM Division, 2900 MacArthur Blvd., Northbrook, IL 60062.

Okidata introduced the Microline 83 at the top of its office printer line. Faster than its sibling, the 83 prints bidirectionally at 120 cps. It produces 136 columns on 15" wide forms at the standard 10 cpi spacing and will also print condensed characters to provide up to 132 columns on narrower forms. Centronics parallel and RS-232C serial interfaces are standard. Okidata Corporation, 111 Gaither Dr., Mt. Laurel, NJ 08054.

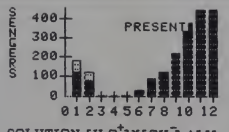
Epson America was showing the MX-80FT, a tractor and friction feed dot matrix printer which features expanded, condensed, condensed/expanded, double-strike and emphasized printing modes. It also

!"$&'()*+,-./0
123456789:;=?A
BCDEFGHIJKLM
NOPQRSTUVWX
YZ`abcdefghijklmn
opqrstuvwxyz

These decorative characters were generated by Sam '76 software on an Apple with Z80 card running under CP/M, and printed on an Epson MX-80. Other fonts are also available.

allows the user to switch between fanfold and single sheet paper by flicking a lever. Epson America, Inc., 23844 Hawthorne Blvd., Torrance, CA 90505.

Centronics introduced the Model 739 which prints 7 x 8 dot matrix characters with true underline at 10 and 16.5 characters per inch for data processing tasks and generates N x 9 proportional characters with true descenders for text editing.



Print sample: Centronics 739.

Available with either parallel or serial interface, the 739 also has graphics capabilities and is priced under $1000. Centronics Data Computer Corp., Hudson, NH 03051.

The Model WP6000 Words Plus printer from **Anadex** prints 150 cps in correspondence mode and 500 cps in rough draft or data processing mode. Multiple resident character fonts, as well as optional downloading of other fonts from a host computer, are provided along with proportional spacing, text justification, and the ability to print superscripts and subscripts.

10 point SERIFA character
OPQRSTUVWXYZ abcdefghi
&'()*+,-./½<=>? ● {\}^_{†}~
sin²[³√(4x²)]-log₁₀(2y²)+4z²=18

Print sample: Anadex WP6000.

Available during the fourth quarter of 1981, the WP6000 will sell to OEMs for $1800. Anadex Inc., 9825 DeSoto Ave., Chatsworth, CA 91311.

MPI announced the 99 Omega, a 100 cps graphics printer which provides an 11 x 9 font for correspondence and a 7 x 7 font for data processing, which can be selected in either 80, 96 or 132 column modes. In addition to standard fan fold paper, single sheets may be used. The 99 Omega lists for $899.

Wide Carriages

MPI also announced the Model MP150, a wider, faster version of the 99 Omega which prints up to 226 columns at 150 cps. The MP150 retails for $1095. MPI, 4426 South Century Blvd., Salt Lake City, UT 84107.

Another wide-carriage, dot matrix printer was introduced by DIP, Inc. The DIP-132 is a 132-column printer which features 9 x 9 or 11 x 9 characters, six character sizes, 110 cps bidirectional printing and graphics capability. The printer, priced at $995, can handle single or multi-part forms ranging from 1.5" to 15" wide. DIP, Inc., 745 Atlantic Ave., Boston, MA 02111.

Narrow Carriage

The **Alphacom** Sprinter 40 is a 40-column thermal printer which noiselessly prints four lines per second. Characters are formed in a 5 x 7 dot matrix and have slight descenders. Optional cables and adapters allow the user to interface the printer to most popular personal and business computers. Alphacom, Inc., 2323 So. Bascom Ave., Campbell, CA 95008.

Tiny Teleprinter

The **Qwint** KSR-743, weighing less than 12 lbs. and smaller than a portable typewriter, is a full-feature keyboard printing terminal with RS-232 and current loop interfaces standard. The KSR-744 is a keyboard teleprinter with an internal 103-style modem, and the RO-743 is a receive-only printer.

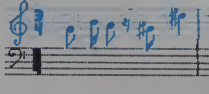
The Qwint KSR-743.

Print speed is over 50 cps and communication speed is selectable over the range of 110 to 1200 baud. Qwint teleprinters also support a graphics mode and provide backspace and forward and reverse half line spacing for printing superscripts, subscripts and underlining. Qwint Systems, Inc., 3693 Commercial Ave., Northbrook, IL 60062.

Colored Tiger

The **IDS** Color Printer is the newest member of the Paper Tiger family of dot matrix printers. Features include text justification, proportional spacing, programmable tabbing, bidirectional printing

Print sample: IDS Color Printer.



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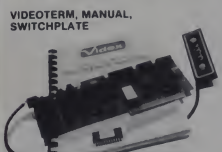
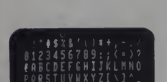
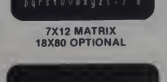




7X12 MATRIX 18X80 OPTIONAL



7X9 MATRIX 24X80 STANDARD

VIDEOTERM

BASICs VIDEOTERM lists BASIC programs, both Integer and Applesoft, using the entire 80 columns. Without splitting keywords. Full editing capabilities are offered using the ESCape key sequences for cursor movement. With provision for stop/start text scrolling utilizing the standard Control S entry. And simultaneous on-screen display of text being printed.

Pascal Installation of VIDEOTERM in slot 3 provides Pascal immediate control of the display since Pascal recognizes the board as a standard video display terminal and treats it as such. No changes are needed to Pascal's MISC INFO or GOTOXY files, although customization directions are provided. All cursor control characters are identical to standard Pascal defaults.

Other Boards The new Microsoft Softcard™ is supported. So is the popular D. C. Hayes Micromodem II®, utilizing customized PROM firmware available from VIDEX. The powerful EasyWriter™ Professional Word Processing System and other word processors are now compatible with VIDEOTERM. Or use the Mountain Hardware ROMWriter™ (or other PROM programmer) to generate your own custom character sets. Naturally, VIDEOTERM conforms to all Apple OEM guidelines, assurance that you will have no conflicts with current or future Apple II® expansion boards.

Advanced Hardware Design VIDEOTERM's on-board asynchronous crystal clock ensures flicker free character display. Only the use of the Pascal Language card, VIDEOTERM utilizes CMOS and low power consumption ICs, ensuring cool, reliable operation. All ICs are fully socketed for easy maintenance. Add to that 2K of on-board RAM, 50 or 60 Hz operation, and provision of power and input connectors for a light pen. Problems are designed out, not in.

Available Options The entire display may be altered to inverse video, displaying black characters on a white field. PROMs containing alternate character sets and graphic symbols are available from Videx. A switchplate option allows you to use the same video monitor for either the VIDEOTERM or the standard Apple II® display, instantly changing displays by flipping a single toggle switch. The switchplate assembly inserts into one of the rear cut-outs in the Apple II® case so that the toggle switch is readily accessible. And the Videx KEYBOARD ENHANCER can be installed, allowing upper and lower case character entry directly from your Apple II® keyboard.

Firmware 1K of on-board ROM firmware controls all operation of the VIDEOTERM. No machine language patches are needed for normal VIDEOTERM use.

Firmware Version 2.0

Characters 7 x 9 matrix
Options 7 x 12 matrix option. Alternate user definable character set option. Inverse video option

Display 24 x 80 (full descenders)
18 x 80 (7 x 12 matrix with full descenders)

Want to know more? Contact your local Apple dealer today for a demonstration. VIDEOTERM is available through your local dealer or direct from Videx in Corvallis, Oregon. Or send for the VIDEOTERM Owners Reference Manual and deduct the amount it you decide to purchase. Upgrade your Apple II® to full terminal capabilities for half the cost of a terminal. VIDEOTERM. At last.

PRICE:
- **VIDEOTERM includes manual** $345
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If you want to program in BASIC, just put it back into the alpha lock mode, and you have the original keyboard back with a few improvements. Now you can enter those elusive 9 characters directly from the keyboard, or require the Control key to be pressed with the RESET to prevent accidental resets.

KEYBOARD AND DISPLAY ENHANCER is recommended for use with all revisions of the APPLE II. It includes 6 ICs, and EPROM, and dip switches mounted on a PC board, and a jumper cable. Easy installation, meaning no soldering or cutting traces. Also note, default modes are user-switch selectable. You can even remap the keyboard, selecting an alternate character set, for custom applications.

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CIRCLE 240 ON READER SERVICE CARD

NCC, continued...

with logic-seeking, forms control and a high resolution graphics option.

IDS also introduced the product that wins our award for the best name at the show. Tiger Trax is a mylar, pin-fed page carrier that allows users to print on single sheets of paper using the Paper Tiger 460 and 560 printers. Tiger Trax comes in two sizes to accommodate 8 1/2" x 11" or 21cm x 30cm paper. Both sizes cost $16.95. Integral Data Systems, Inc., Milford, NH 03055.

Dataproducts announced the M-100 Matrix Printer. To demonstrate the graphics capabilities of the printer Dataproducts had artist Saul Berstein drawing portraits on an Apple Graphics Tablet and printing them out on the M-100. Some of the ones we saw were quite good, but that was probably a greater credit to Bernstein than to the printer.

Portrait of a publisher by Saul Bernstein and the Dataproducts M-100.

In addition to its ability to print very high resolution graphics, the M-100 can print superscripts, subscripts, true underlines, and lower case letters with descenders at the rate of 140 cps. An 8-bit parallel interface is standard, and RS-232, current loop and Centronics interfaces are optional. The M-100 sells for $2995. Dataproducts Corporation, 6200 Canoga Ave., Woodland Hills, CA 91365.

Daisy Wheel Printers

Alphacom also announced a daisy wheel printer—the DP2000—which sells for $1595. Features include programmable print parameters; incremental horizontal spacing and tabulation to 1/120 of an inch; horizontal and vertical tabbing functions; right and center justification of text; bidirectional friction feed platen; 10, 12 or 15 cpi or proportional spacing; and standard 8-bit parallel interface with optional RS-232 interface. Print speed is 20 cps. Alphacom, Inc., 2323 So. Bascom Ave., Campbell, CA 95008.

Programmable print parameters such as margins, tab stops, boldface printing, form length, automatic underline, and overstrike characters

Incremental horizontal spacing and tabulation to 1/120 of an inch

Horizontal and vertical tabbing functions

Print sample: Alphacom DP2000.

While not exactly a daisy wheel printer, the Converter TP121 allows the user to connect an Olivetti ET121 electronic typewriter to a computer. Connecting the converter requires no soldering or modification to the typewriter. Available interfaces include RS-232C serial, parallel and IEEE. The Olivetti typewriter retails for $595 and the converter for $295. Vertical Data Systems Inc., 1215 Meyerside Dr., Unit 2A, Mississauga, Ontario, Canada, L5T - H3.

Touching and Talking

Among the more interesting new products at NCC were a touch-sensitive terminal and a talking terminal.

The Dialogue Touchterm 80 introduced by **Ampex** responds to the user's touch on its screen. The specifications state that practical stylus sizes range from a pencil eraser or finger to a gloved hand.

The user can either draw on a blank screen with his "stylus" or use it to select options from a menu printed on the screen.

The Dialogue Tochterm 80.

For example, the demonstration running in the Ampex booth was designed to help a show goer select a restaurant in the Chicago area. After choosing (by touch) a general type of restaurant, the weary NCCer could choose (by touching its name on a list) an eating place about which he wanted more information.

Possible applications for touch input include bilingual communication, order entry, industrial switching, security systems, computer aided instruction, and other tasks where touching is more reliable than typing. Ampex Corporation, 200 North Nash St., El Segundo, CA 90245.

When hearing is more reliable than sight, the Votrax Type-'n'-Talk synthesizer can be used. The computer can either speak the words as they are typed or wait until the user requests them. Using the synthesizer, a computer can orally take a user through a complex routine, prompting him through a financial or accounting process, for example.

Used as a teaching aid, it can tell students when and why they have answered a question or performed a function correctly. The possibilities for use in game software are limited only by the imagination of the programmer. Type-'n'-Talk sells for $345. Vodex—A Votrax Company, 500 Stephenson Highway, Troy, MI 48084. □

Saul Bernstein sketches Betsy Staples on the Apple Graphics Tablet.

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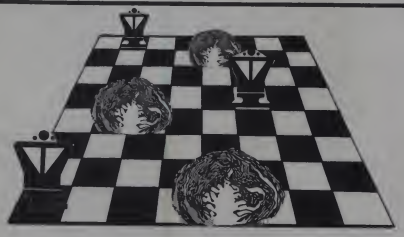

Of Cabbages and Kings

Stephen Kimmel

"The time has come," the Walrus said,
"To talk of many things:
Of shoes and ships and sealing wax
Of cabbages and kings
And why the sea is boiling hot
And whether pigs have wings."
—Lewis Carroll

If you've read *Through the Looking Glass* you know that Alice encounters a vast assortment of chess pieces. Most talk and many aren't quite what they appear to be. In many respects, *Through the Looking Glass* is Lewis Carroll doing to Chess what he did to playing cards in *Alice's Adventures in Wonderland*. The adventures are just as strange. In many ways it is like running this tournament.

The editor of this sage publication was so impressed with the job I did last year—sometimes they are easy to impress—that she asked me to do it again. Mad fool that I am, I accepted. Here then, gentle readers, is the journal of my adventures in the looking glass house of computer chess.

As you recall from our last episode, I had worked my way through five programs and dedicated computers armed to the teeth with salt and healthy skepticism. Two of the products, Microchess 1.5 and the JS&A Chess Computer, were found to be sadly wanting. I predicted that they would either be replaced by better products or would disappear. JS&A has dropped out of the computer chess business. Occasionally you'll still find Microchess in a Radio Shack and in large software house ads. Normally they say that its principal asset is that it is easier to beat than Sargon. One product, Boris, was found to be adequate. Sargon and Chess Challenger 7 were easily the best of the group. I predicted upgraded versions of those products. And we've gotten them.

Stephen Kimmel, 4756 S. Irvington Place, Tulsa, OK 74135.

Cabbages

Shortly after last year's tournament we got our first entrant for this year. It was a listing from Roger Brown's "Basic Software Library." Those are the large orange books that go for around $20 apiece. Being a registered idiot, I started typing it into my trusty TRS-80. Hours later, with sore fingers and strained eyeballs, I had it up and running. Several hours later I had it making nothing but legal moves and playing with a modicum of sense.

Chess in Basic? Yep. Consider: essentially all chess programs are written in machine language for one fundamental reason—speed. To make a good chess move using current decision strategies requires examining hundreds of possible combinations. For a more extensive discussion of how this is done I'll refer you to David Levy's column, "Intelligent Computer Games." Even in machine language, some of the programs seem awfully slow and arrive at imbecilic moves.

How will a Basic program that plays chess act? If it tries to go through the entire search procedure as currently implemented, the computer will appear to have locked up. It may take the program hours to arrive at pawn to king four. The other choice is to make a very shallow search that can be done in a reasonable amount of time. Of course if you can't see beyond the end of your nose you'll play terrible chess.

Basic Chess plays the worst game of chess I have ever seen from a program, a rank beginner or a chimpanzee. I tried. I couldn't lose to it. It doesn't see deep enough to know if you are in checkmate. Figure 1 is from a game with my human player. You will note that Basic Chess has taken a pawn with its queen and has the human in check. You will also note that the queen is sitting directly next to the king and is undefended. Net result: Basic Chess has just swapped its queen for a pawn. The display is as marginal as is conceivable.

As Thumper said in that immortal classic of pride and passion, "Bambi," "If you can't say something nice, don't say anything at all."

BASIC CHESS

BR	BN	BB		BK	BB	BN	BR
BP	BP	BP		BP	BP	BP	BP
				WN			
WP	WP	WP	BQ		WP	WP	WP
WR		WB	WQ	WK	WB	WN	WR

HUMAN 1000

Figure 1. Basic Chess captures the queen pawn and puts white in check...demonstrating just how bad a chess program can be.

The Basic Chess program has one nice feature. Since it is written in Basic, it is easy to figure out what is going on inside of it. And it is a snap to make it play better. That's not quite a good enough reason for me to fork out the $39.95 for the book. I have no use for the medical billing program, the word processor or the utility program that round out Volume VII of the series. Nor would I spend the $9.95 for the cassette tape available if you call 800-528-6050. But, if your money is burning a hole in your pocket that badly, send me some of it and I'll send you some notes on improving the program and a deed to the Brooklyn Bridge.

Basic Chess lost all of its games convincingly. I can't calculate a rating low enough to include it. I have finally found a computer chess program bad enough to

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RCA

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lose to *Microchess*. These were the only games Microchess won in this year's tournament. If these two programs were on a vaudeville stage they would be up to their ears in cabbages and tomatoes.

Enter Creative Computing

The second program to come in was Z-Chess which is offered by the Software Association (713-482-0883) and Creative Computing Software (800-631-8112). Say, that second group has a familiar sounding name. Now you might wonder if that will bias my report. I ask no quarter and I give none. I will take no prisoners. I will, however, tell you what is good about Z-Chess before I tell you what is wrong with it.

Z-Chess fits the mold of the Creative Computing image of the human-computer relationship. In the early days of personal computing—forgive me this brief digression, I promise that I will tie it all back together—computer programs and games were difficult to operate. The usual mold was for them to be abusive and offensive. It was a common occurence to push a wrong button and have your computer say: "Because of your complete incompetence, the Klingons have taken over the Federation, you stupid jerk!!

It appears to me that the software people at Creative Computing believe that computer programs should be easy to operate, congenial and generally a pleasant experience. Their software frequently has heaps and gobs of instructions and sometimes will even give examples of the play. The formats are designed to be easy to work. It seems that it is more important to Creative that the program be easy to work than to have it do the best possible job.

Z-Chess is the easiest computer chess program to use. You don't have to learn strange nomenclature or consult page 14 of the instruction book. There aren't any secret sequences of keys necessary to show the board. All of the squares are numbered and all you have to do is type the number of the square you want to move from and the number of the square you want to move to. It's that simple. The program is ruthlessly forgiving on input.

It's too bad it doesn't play very good chess.

The ads say, "Possibly the fastest good strategy chess game available." That statement requires closer examination. Note that it said "possibly." It isn't the fastest good strategy game available. The use of the word "strategy" rather than the word "tactical" normally means that it has the right theory in mind but that it may slip up on the little details. The advertisement is mostly smokescreeen and double speak.

The graphics are somewhere between adequate and mediocre. The king and queen are differentiated by the letter on

the top. The squares are backwards. The square in the lower lefthand corner is supposed to be white rather than black. (This has been corrected in the new version, Z-Chess III, which also incorporates an improved strategy.)

Z-Chess stomped Microchess and Basic Chess but that doesn't take too much. It lost games to Sargon and Human 1000.

At this point I was afraid that the prospects of having a good tournament were pretty bleak. Perhaps there would be no drama this time, no waiting for the outcome of the final game to determine the winner. Perhaps there would be nothing but mediocre new entrants. Perhaps there would be no serious challege to last year's winner, Sargon. The next entrant gave me nothing to hope about.

Chessmate-80 is a product of the Instant Software line. You can order one by calling 603-924-7296. It is perhaps best considered by comparison to Z-Chess which is about its closest match in this tournament. Chessmate has a Basic language loader that displays commercials while you wait for the program to load. It's kind of a cute idea. I would have perferred instructions, graphic display, practically anything. Still it does beat watching the little flashing stars.

The instructions to Chessmate-80 are difficult at best. After three games, I lost the instruction sheet. I was unable to make the program do anything until two weeks later when the new set of instructions arrived. They were very good about that. Actually I was able to make the game show the square numbers by simply pressing the "I" key. That is a very nice feature. I could play a plain vanilla game of chess but I couldn't remember how to castle. Several games later I am still helpess without the instruction sheet. You see, the program has so many features and functions that it takes a rather complex instruction entry procedure. "/A(Enter)" makes the program display all the moves that it considers. I consider all this unnecessarily complex.

The graphics are nice enough considering that it is on a TRS-80. At least they have the color of the squares right.

Unfortunately, Chessmate-80 doesn't play very good chess either. It beat—ho hum—Basic Chess and Microchess impressively. And it lost both games to Z-Chess. The advertisements talk about how you might be embarassed to play Chessmate-80 in public. Well, if you are very easily embarassed or you're a bad chess player, or you might be embarassed to be seen in public with Chessmate-80. At $9.95 (plus $1 for shipping and handling) Chessmate-80 is the cheapest chess program around that is worth playing. That seems to be its principal redeeming virtue. I consider Chessmate-80 and Z-Chess to be about on a par with our old friend Boris with Z-Chess being slightly better and Chessmate-80 being slightly worse.

And Kings

Which brings us to our old friend **Boris**. Where is Boris? What happend to Chafitz and the computer chess game they claimed would always be king? Well, it seems that Chafitz is out of the chess business. According to their press release, "Chafitz, Inc. has announced that its Special Products Division will no long be distributing chess products. Chafitz has taken this action in order to concentrate more of its resources on expanding its well established Retail Division, which is a leader in the Washington area consumer electronics market. Their recent entry into personal computer sales has been extremely successful and they are implementing some innovative marketing plans in the video market." The Chafitz press release goes on to say that they have completed licensing agreements for the "revolutionary" Auto Response Board with AVE microsystems and that Chafitz is negotiating the rights for the other products.

A quick call to AVE Microsystems got Dale Folwell, president of the company. According to Mr. Folwell, AVE has always been the manufacturer of the Auto Response Board. They plan to work through the same sort of distribution system that the Boris unit has always gone through. He offered to send us one of their $475 models for use in the tournament. Drooling, I accepted.

It seemed obvious to me about this time that Sargon was going to be the champion again. It had handily dispatched the new entrants. If the Auto Response Board was simply a recycled Boris program in a fancy new wrapper, then it would mount no serious threat to Sargon's supremacy. Yet another new program came in about this time and ended any serious possibility of a repeat winner. When Sargon fell from serious consideration, it fell without a whimper. Sargon was lifted up, carefully peeled, dissected, and thrown away like the used wrapper from your local deathburger joint. The new program was clearly

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a superior chess player and it further demonstrated it by beating Z-Chess and Chessmate-80, and (Do I have to keep saying it?) Basic Chess and Microchess were laughed out of the tournament. We watched silently as the newcomer devastated everything in sight.

Sargon II had arrived to lay claim to the crown. The advertisements state it simply enough: the best has gotten better! The program has a new set of graphics about which I have mixed feelings. It has faster levels of play and a new level 0 for those of you easily intimidated by Sargon's play at its better levels. Don't feel bad. Sargon at level 3 is better than the majority of human players. And there are three levels above that. The program even has a hint feature that tells you what it thinks your best move is—I think. It is possible that Sargon is giving you slightly inferior moves, but that would seem extremely petty of such a fine program. All in all this is a fine program although the price, $29.95, is steep.

Of course, this might well be the end of the story. A worthy champion had been found. But that would be both dishonest and rather dull. As it turned out there were serious challengers to threaten Sargon II's claim on the crown. I wasn't ready to hand first place to Sargon II.

The Challengers

The package that brought the Auto Response Board from AVE Microsystems was huge. It could easily have been used for the top of a nice card table. Drooling on the wife's new carpet, I tore away the box to reveal the new dedicated chess computer. I gasped. It was magnificent. It was beautiful. It was obviously what God intended a dedicated chess computer to look like. It was a two foot square of inlaid hardwoods with tiny red lights in the corners of the squares and unobtrusive buttons down one side. A second package contained the largest transformer I've ever seen and the best set of chess pieces I've seen in ages. It was what you would expect if you'd paid $475 for an electronic game.

Then I noticed the name. It said Chafitz all right. It also said, "Auto Response Board Sargon 2.5 Computer Chess Program." Sargon 2.5? I had heard that Chafitz had hired the now famous Spraklens to work on their Boris program. What apparently has happened is that Boris has been dumped completely, remaining perhaps in the little Boris Diplomat units, in favor of an updated version of the Sargon program. Or is it? The name implies that this is a later product. Is it just some new form of advertising hype? Are they just using the name to imply something that isn't true? Perhaps the only modification is the change in the input and output routines. It demanded an immediate match with Sargon II to set the issue straight.

But alas, gentle reader, the issue isn't that simple. There is yet another serious challenger for the crown. This one was expected, although I must confess that its strength surprised me. Atari has been making fine video games for a number of years and is a recent entrant into the personal computer field. I happened to have a Video Computer System to provide the color graphics and sound for the games I need to keep my kid from throwing away my life savings on the Atari games in the arcades. My kid is three.

For this tournament we used the cartridge program for my video unit. The play is with the joysticks, which is quite a switch from the strange nomenclature of most of the programs. You simply direct an X to the piece you want to move. When you get there you press the red button to "pick up the piece." Move the X again until you find the right place and press the red button again. The move is made and the computer begins to think by throwing the screen into a wild series

Perhaps there would be no serious challenge to last year's winner, Sargon.

of color contortions. The screen reappears with Atari's move. The X shows where the piece came from and the moved piece flashes so that you can tell immediately where it went. What could possibly be simpler?

The graphics are really strange on the Atari. The board has a huge amount of blank space all around. They haven't made much of an effort to make the board as large as possible. With a relatively small TV set like mine this can get to be a strain. The computer makes a particularly offensive sound when it has you in check. I suppose it goes without saying that when you have a few controls available that setting up a special position is a pain in the neck.

But the Atari program does know how to play chess. It has an opening book like the best programs. Its play seems to be free of gross errors and there are no obvious stylistic errors.

One last serious challenger made it in time to be included in our tournament. Another brief digression: the world chess tournament for computers has been the habitual domain of the monster computers. The championship seems to be permanently resident with Chess 4.9 or Belle or Duchess. All of the programs run on the giant computers. There are two smaller programs that have made serious inroads into this territory and have begun laying waste to the theory that a good chess player has to be as big and as fast as a Cray-1. One is the Sargon 2.5 Auto Response Board, which finished seventh in last year's tournament. It came close to winning its game with Belle, the second place program, but blew a won game. That loss was in part responsible for the other program on a reasonable size machine finishing sixth in the tournament.

David Kittenger's Mychess is a terrific program that runs on the Cromemco Z2D and Z3D machines. Both are substantially larger than my TRS-80, but they will fit in a regular office and still have room for something else. And you get them for under $20,000. Because of its high finish and the difficulty in finding a $10,000 computer to borrow I decided to hold Mychess out and have the champion play it in a special pair of games.

If you have a Cromemco machine that takes 8" floppy disks and if you have any interest in chess then you absolutely have to buy Mychess. Forget the Dazzle chess the Cromemco dealers push. It is bad. And it requires that you have a color TV. Mychess requires only the machine. By now Kittenger may even have it on 5" floppies. You can order by writing to Computer Services, 2431 Lyvona Lane, Anchorage, AL 99502.

I suppose this is the appropriate time to say something about the **Chess Challenger** line. There are at least two new products in this fine group, The Voice Challenger and the Sensory Challenger. Except for the display at my local Sears I haven't seen either one. I am told by owners that the changes are superficial. Voice Challenger, as you would expect, talks to you confirming your move and its move. Sensory Challenger, I understand, senses the movements of the pieces. I'm afraid to say more since that's all I know. Fidelity did not send in a machine for us to use. Since I was on my own finances, I went for cheap and got the old Chess Challenger 7, which you can get now for under $100.

Tweedledum and Tweedledee

The required matches between **Sargon 2.5 Auto Response** and **Sargon II** began with Sargon 2.5 playing white. Sixty-four moves later, the longest match of the tournament, Sargon 2.5 emerged the winner. Obviously the improvements aren't too great. The advanced Sargons play a very similar game, surely the mark of Dan and Kathe Spraklen. After achieving the material advantage of a piece or a couple of pawns, they begin to remove pieces from the board with almost reckless abandon. It is almost always an even swap. Frequently the swap is made in such a way as to inflict structural damage as well. In my judgment, this is very sound

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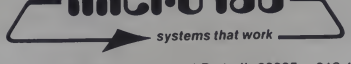

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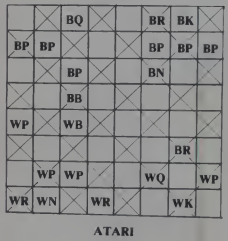
SARGON 2.5



ATARI

Figure 2.
20 ... RxP!ch
21 PxR BxQ ck
Eliminates all doubt about the outcome. Why not 21 QxR? Because the queen cannot move without putting white in check.

	Atari (white)	Sargon 2.5 (black)
1	P-Q4	N-KB3
2	N-KB3	N-QB3
3	N-QB3	P-Q4
4	P-K3	B-N5
5	B-Q3	BxN
6	QxB	P-K4
7	PxP	NxP
8	Q-K2	B-B4
9	O-O	O-O
10	R-Q1	Q-Q3
11	B-K4	P-B3
12	P-QR4	KN-N5
13	P-KN3	Q-K3
14	B-Q3	QR-K1
15	B-Q2	P-Q5
16	B-B4	Q-B1
17	N-N1	PxP
18	BxP	NxB
19	PxN	RxP
20	Q-B2	RxP ck
21	PxR	BxQ ck
22	KxB	Q-B4 ck
23	K-K1	QxP
24	N-B3	R-K1 ck
25	K-B1	N-K5
26	K-N1	Q-B7 ck
27	K-R1	NxP checkmate

chess—if somewhat dull. A three pawn advantage may not seem like much when the board is full of pieces but when there is only one piece and three pawns against one piece and six pawns the eventual outcome is no longer in doubt. Both Sargon 2.5 and Sargon II do this.

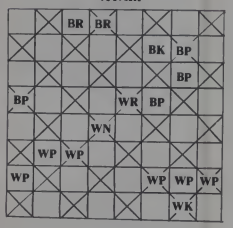
Sargon 2.5 has one other feature that none of the others has. Most of the programs sit there and scan the keyboard waiting for you to make your move. Not Sargon 2.5. When you think about what it should be doing, it becomes obvious. The computer is sitting there thinking about the keyboard. Why not have it think about the game and check the keyboard every few milliseconds? The only question is what it will think about. Both of the Sargons give hints about your best move. Sargon 2.5 assumes that you will make the best move and then thinks about what it will do when its turn comes again. See? I told you. Obvious.

During the course of a tournament there is always a need to leave the machines for a brief time. I always felt like I was cheating when I left Sargon 2.5. Its opponent would make its move and wait while Sargon 2.5 would be doing progressively deeper and deeper searches.

Then why doesn't Sargon 2.5 play better chess than it does? the program has a fatal flaw: it will not settle for a draw! Be it behind or be it ahead, if it looks as though it is going to settle into a stalemate by repetition, Sargon 2.5 will pick an inferior move. It cost Sargon 2.5 the second game with Sargon II. In 63 moves, Sargon II had drawn even with its supposedly vastly superior brother.

Enter **Atari Video Chess**. When Atari played Sargon 2.5 as white, the game was over in a mere 27 moves. The match was no longer in doubt after move 20 shown in the diagram. Of course, we wrote this off as insignificant. Sargon 2.5 had simply destroyed another inferior program. Or so we thought. The second game also lasted 27 moves. It also demonstrates the classic flaw of Sargon 2.5. Despite what might be described as a terrible move at move 17, Sargon 2.5 is still even materially and Atari's pawn structure is in shambles. With Atari's move giving it the possibility of a quick mate (any rook to the last file) Sargon 2.5 begins the fatal series of moves. They dance a quick polka of checks and Atari king moves. Seeing that they are on the verge of a stalemate Sargon 2.5 choses the final knight move. Why not move a pawn and make checkmate impossible? Why not the bad king to bishop one or the terrible knight to bishop three? Who knows what evil lurks in its electronic heart? Instead, Sargon 2.5 picked the worst possible move and threw the game away. Atari, being no fool, moved the appropriate rook and ended the claim of Sargon 2.5 to clear superiority.

ATARI



SARGON 2.5

Figure 3.
RxRP RxP
R-R7 ck K-B3
R-R6 ck K-B2
Leads to a potential stalemate by repetition. Sargon 2.5 chooses to throw away the game instead.

	Sargon 2.5 (white)	Atari (black)
1	P-K4	P-K4
2	N-KB3	N-QB3
3	B-N5	N-K2
4	P-Q4	PxP
5	NxP	P-Q4
6	N-QB3	B-K3
7	B-N5	PxP
8	BxN(B3)	PxB
9	BxN	BxB
10	NxP(B3)	QxQ
11	RxQ	B-KB4
12	N-N5	B-Q3
13	NxB ck	PxN
14	RxP	R-QB1
15	O-O	P-QR4
16	R-K1	B-N3
17	RxB???	RPxR
18	RxP	K-B1
19	N-Q4	P-B4
20	R-K6	K-B2
21	R-K5	KR-Q1
22	P-QB3	R-QN1
23	P-QN3	QR-QB1
24	RxRP	RxP
25	R-R7 ck	K-B3
26	R-R6 ck	K-B2
27	R-R7 ck	K-B3
28	N-K2	R-Q8 checkmate

Sargon 2.5 chooses to throw away the game rather than settle for a stalemate and in doing so throws away the tournament.

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Cabbages, continued...

Could it be that the unheralded Atari was actually the best chess playing product available this year? Stay tuned and find out.

The second half of the tweedledum tweedledee team of Sargons then took its shot at the upstart Atari. The diagram of this game shows a typical position for the current Sargons. The pawn advantage of Sargon II should be enough to assure the eventual outcome of the game. Sargon II has overlooked one small detail, however. Atari has a forced mate in two. I'll leave it to you to pick out the required moves. Positions like this clearly demonstrate how deeply a program can examine a position. Fortunately for Sargon II, Atari has also overlooked the forced mate in two. About a million moves later, Sargon II cashes in its pawn advantage and makes a quick(?) end of it. The second game ended more quickly. Thirty moves into the game, Sargon II had a one pawn advantage but Atari had a better pawn structure. Neither one could decide what to do. They spent the next ten turns making the same moves over and over again. It ended in a stalemate by repetition.

Figure 4. Atari has a forced mate in two moves, but lacks the depth to see it...and so moves RxP instead.

And The Winner Is...

And now for something completely different. If you read the report of last year's tournament (soon to be a major motion picture) you will have noticed the lack of human players. This is simply a matter of self-defense. Last year we had five electronic players and two humans. We played 42 games. It came close to breaking up my marriage. This year we have ten electronic players. That's 90 games and my wife is in Wisconsin on a prolonged visit with her grandmother. Add two humans and you have an additional 42 games. That's as many as last year's total! Should I put in three times as much work this year? Sorry, boys and girls. No way.

The winner of last year's tournament was Human 1400, not Sargon as some would have you believe. This year he only played my leading contenders: Sargon II (14-1-1), Sargon 2.5 (14-2-0), and Atari (13-2-1). The outcome of these matches would determine the winner and which program would go on to challenge Mychess. Human 1400 learned his lesson about electronic chess players in last year's tournament. They are relentless and they never make mistakes of simple oversight. Human 1400 takes none of the programs lightly and doesn't start laughing until he is well ahead. Human 1400 brushed aside Atari in two quick games and it was clear that he was playing at close to his potential. It was also clear that Atari wasn't all that good. It is probably about as good as the old Boris units.

Sargon II fared a little better in its first game and managed to defeat Human 1400 as black. As white, Sargon II collapsed into defeat and ritual suicide. This put the pressure squarely on Sargon 2.5. It could still win the tournament with a victory and a draw against Human 1400. Two victories would make it clear cut. To be

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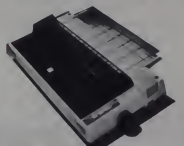

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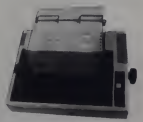

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perfectly fair, none of these programs is designed to play other computers. They are designed to play humans. Human 1400 was on the ropes against Sargon 2.5. Despite playing a basically solid game he was losing to the electronic thoroughness of the machine. Perhaps in desperation, Human 1400 moved his king from bishop two back to bishop one. Those of us who had watched Sargon 2.5 work its way over the others held our breath. Sargon 2.5 repeated its move. Human 1400, who was breathing noticeably easier, continued the invitation to stalemate by moving back to bishop two. He hoped that he would sneak out with an undeserved stalemate. We waited to see if Sargon 2.5 would make some drastically horrible move. Finally the machine moved. It wasn't a horrible move. It was merely inferior. Sargon's great flaw had risen once again like something out of a Greek play. Human 1400 sat without moving for a full minute before seizing the opportunity and eventually cashing in for the victory. The flaw had cost Sargon 2.5 a game against Atari, it had done it again with Human 1400 and it lost the tournament.

In what should probably be considered a major upset Sargon II had defeated Sargon 2.5 for the right to meet Mychess. In the final analysis the tournament pivoted around the fact that Sargon II was willing

Figure 5. Mychess to move. 22... BxN(F6xC3) and Mychess announces mate in eight.

to settle for a stalemate with Atari. If it weren't for the flaw Sargon 2.5 might be—would be—the better program. But that qualifies as Monday morning quarterbacking.

Sargon II played two games against **Mychess**. The first one seemed to go on forever, lasting 61 moves. Both programs did an exceptional job of predicting the moves of the other. Mychess, like Sargon 2.5, thinks on the opponent's time. Thus, it can see the position deeper and eventually won the game. The diagram shows a position from the second game. Mychess proclaims the best series of moves, a full eight moves ahead! This is an incredible feat for a small computer program. Sargon may be capable of it but somehow I doubt it. The next eight moves click off neatly with only one variation from Mychess's proposed continuation. At move 29 Mychess completes the kill and defeats Sargon II for the second time.

The Dust Settles

Did we actually see a match of programs or was the outcome foreordained by the fact Sargon II was playing on a TRS-80 with its 1.77 mhz clock instead of the Cromemco Z-80 with its 4.00 mhz clock? I tend to think so, but I would like to see the two play on a more equal footing. The Spraklens' tournament version of Sargon has defeated Mychess before. Nevertheless, Mychess is the finest chess playing program commercially available. I just hope that Kittenger puts in the effort and translates the program to run on something a little more common than the Cromemco Z2D.

Sargon II is the best program available for the Apple and the TRS-80. Sargon 2.5

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is the best dedicated player currently available although I haven't had the opportunity to see Radio Shack's new machine. Chess Challenger 7 is still a fine machine and for the money is probably a better buy than Sargon 2.5. If you own one of the Ataris and are interested in chess, then by all means buy a Video Chess program for it. Assuming, of course, that you aren't like me going "gasp, choke, cough, cough, cough" when you see a $45 price tag.

The chart indicates the final outcome and my guess as to the rating of the various programs.

The Future

What will the future hold for computer chess? There are three developments that I find extremely interesting. Both JS&A and Chafitz have gotten out of the dedicated chess computer business. Fidelity seems to be keeping a lower profile. It could very well be that the market for dedicated chess computers is approaching saturation. The novelty has worn a little thin and there simply aren't that many people willing to plunk down $100-$500 for a machine that doesn't do anything but play chess.

If there was much of a future in the market I would expect Texas Instruments to be in there. They have a program. They have the expertise to make a competitive product. You would tend to conclude that there is no market. On the other hand Tandy is introducing a dedicated chess player. Tandy has made some mistakes in their day and I think this is another one. I expect that by Christmas of 1982 the Tandy chess machines will be gone.

On the other hand, chess programs are now as common as personal computers. Although Microchess has functionally disappeared from the market there are several others to take its place. It almost seems to be a requirement that a home computer have a chess program. I would be interested to see what percentage of people own one. Each of the current programs seems to be carving out its own comfortable niche. The Sargons are available for the good player. Z-Chess is the program for the novices. Video Chess is for the Atari. Mychess is for the Cromemco series.

Will there be other programs? Possibly not. The major software lines all have programs. There is very little prospect for success with a new program.

Still there are 400,000 programmers out there working on personal computers and I'm sure some of them are working on chess programs. You will probably start seeing advertisements selling chess programs you've never heard of, and all you have to do is send your $14.00, cash or check, to apartment 322. After a few months the ads will disappear. The programmer trying to sell his own program will have run out of money. On the other hand, if your program can beat Sargon, there is hope for you. It may take a while but there is hope. Kittenger, for example, may decide to translate Mychess for the TRS-80.

One thing we can say with certainty is that computer chess is out of the dark ages. Now the winners can really be called kings. We will have to save our cabbages to throw at some other stage.

Special thanks go to Dick Havens of Computers International of Tulsa for the loan of the Cromemco Z2D, to Rick Helmrich for the loan of a TRS-80 and to Gary Krasner who played several of the games.

	My Chess II	Sargon 2.5	Atari Sargon I	Challenger 7	ZChess	Chessmate 80	Microchess 2	Basic Chess		
Mychess	W: * B: *								2-0-0	1600
Sargon II	W	:	*	-	*	*	*	*	*	*	14-1-1	1400
	B	:	*	*	*	*	*	*	*	*		
Sargon 2.5	W		:		*	*	*	*	*	*	14-2-0	1500
	B	*	:	*	*	*	*	*	*	*		
Atari Sargon I	W			:	*	*	*	*	*	*	13-2-1	1250
	B	-	*	:	*	*	*	*	*	*		
Challenger 7	W				:	*	*	*	*	*	9-7-0	1200
	B				:		*	*	*	*		
	W				*	:	*	*	*	*	9-7-0	1200
	B					:	*	*	*	*		
ZChess	W						:	*	*	*	6-10-0	1000
	B						:	*	*	*		
Chessmate 80	W							:	*	*	4-12-0	800
	B							:	*	*		
Microchess 2	W								:	*	2-14-0	500
	B								:	*		
Basic Chess	W									:	0-16-0	2007
	B									:		

Figure 6. The results of the individual matches.

Mope Kings

I'm a firm believer in the fact that Murphy was a prophet of God. I finished putting in a couple of hundred hours on "Of Cabbages and Kings" (about which time I couldn't have cared less if I never saw another computer chess game again in my life) and along comes a group of new products to make me look bad. Gambiet 80 claims to be "The World's #1 Microcomputer Chess Program." A TRS-80 version of Mychess appears claiming to be "King of the Hill" and to thrash routinely the various Sargons. None of which keeps Sargon from claiming to be the "state of the art." Indeed, Sargon seems to be the whipping boy in just about everybody's ads. If you can't do anything else, you can always claim to beat Sargon.

All of these conflicting claims started my adrenaline flowing. They can't all be right! Somebody is not telling the entire truth! Despite all my good intentions to give up computing and become an axe murderer, I was irresistibly drawn to borrow a computer and sit down again locked hypnotically to the CRT. I am a creature driven by primal forces to expose false claims. I am a barely credible hulk rampaging through microcomputer chess programs.

The version of Mychess I had earlier was designed for the Cromemco with its 4 MHz clock. That's twice as fast as the TRS-80 I had Sargon II running on. But the question remained; how much of Mychess's crushing victory was due to the clock and how much was due to superior chess playing ability? Since both computers are Z80 based, the difference should be significant.

Mychess, from Programma International ($34.95, 2908 North Naomi St., Burbank, CA 91504, 213-954-0240) is, in fact, the same program. All David Kittenger and company did was to change the addresses from the Cromemco's free low memory to the TRS-80's free high memory. They have added a save game feature to allow you to save up to six games in progress. The program will run on a 32K TRS-80 with one disk drive.

Since Mychess is so large—at 30K the largest program I've seen on a TRS-80—it has to have its own DOS. They have taken this opportunity to introduce Securdos which very effectively prevents unauthorized copying. I ruined my one legal copy and none of the programs I had would even begin to copy it. So I proceeded with extreme caution.

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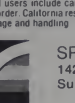

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As you might expect, Mychess suffered from the slower clock. It was, however, still up to beating Sargon II. The first game gave every indication of going on forever. After four hours and sixty moves, Mychess had a commanding lead, but seemed to be having some trouble making the final kill. I awarded the game to Mychess and reversed the boards. The second game, however, had a slightly different outcome. Four hours later, Sargon II was a full rook ahead and was merrily picking off Mychess' remaining pieces. This game seemed beyond doubt so at 2:30 a.m. I declared it a win for Sargon II and went to bed. I was the first time in my experience that a Sargon program had beaten Mychess.

Mychess claims in the documentation that it has won 20 of 24 points with Sargon 2.5 or about five out of every six matches. The Sargon 2.5 I used refuses draws—a major flaw. Sargon II doesn't have that flaw and should be able to beat Mychess... perhaps...once out of every four matches. I've played the programs against each other four times now and the one in four ratio seems fairly sound.

Mychess is *not* a polished commercial package. It desperately needs something to indicate that it isn't hung up. My printer caused that to happen several times and there isn't a clue except that an exceptionally long amount of time has passed between moves and the fact that the keyboard won't respond. The graphics are non-existent and would look the same if done on a teletype. The Securdos is troublesome and occasionally fails to read correctly. In fact the only thing Mychess has going for it is the fact that it plays exceptionally good chess—for a small computer.

With the relationship between Sargon II and Mychess firmly established, I moved on to Gambiet '80. By the luck of the draw it got to play Mychess first.

Gambiet '80 is a European program by Win Rens handled by the Microtrend organization. It sells for $39.95 (the most expensive chess program I've seen) from Microtrend, USA 1900 Plantside Dr., Louisville, KY 40299 (800-626-6268). Its early advertisements claimed it was the world's best. Later ads merely state that it is "A Microcomputer Chess Program in a Class of Its Own." Difficult to really attack that. Microchess is in a class of its own, too.

To a large extent, Gambiet '80 is like all the others. It has reasonable, if slightly small graphics. The display always shows the last twelve moves and the numbers on the squares. If you have an expansion interface it will display the time for each player. Gambiet also gives you the option of printing the moves. All of which is very nice, but if you are going to be the world's best you have to *do* it *with* playing ability.

In the first game Gambiet was so busy chewing up Mychess that it hardly paused to belch. It attacks ruthlessly and has no compunction about clearing the board of pieces. Mychess' predictions were consistently wrong, calling for major pieces when Gambiet moved pawns and pawns when Gambiet moved major pieces. That tended to make Gambiet look brilliant and Mychess look like an idiot. I haven't seen a game so fast since Boris dismantled Microchess.

I was satisfied that the Gambiet ads were right. My task seemed straightforward. After beating Mychess, Sargon should go the way of all programs and Gambiet would be the new champion. One minor technicality: Mychess refused to cooperate, vowing to fight to the end. Mychess picked the rather off-beat English opening, pawn to queen bishop four. Gambiet was beaten on the opening move. Gambiet has no opening book preferring to calculate for basic principles. It seems to work fine on king pawn openings and isn't too bad on queen pawn openings. Gambiet is, however, quickly cut apart by irregular openings and is a sucker for gambits.

So now it fell to Gambiet to recover its besmirched dignity, beat Sargon II and demonstrate its claim to world domination. Another small difficulty reared its ugly head to spoil the scenario. Sargon II didn't win those tournaments by rolling over and playing dead. It is a salty competitor that is almost never humiliated. What's more Sargon II and Mychess were in the corner trading notes when I broke them up to continue the tournament. Sargon II offered a gambit and Gambiet fell apart playing into Sargon's capable hands. Combined with an advantage in the opening and their combined willingness to swap pieces, they quickly stripped the board to Sargon's advantage. Finally Gambiet was forced to trade a rook for a promoted pawn and it was all over.

Sargon II won in what might be considered an upset. Only one game remained and suddenly a nightmarish possibility came to mind. If Gambiet beat Sargon II, then everybody would have beaten everybody else and nothing would have been proven. The alternative was that Sargon II would win making it the clear winner despite the technical superiority of Mychess.

The game began, and in Gambiet's usual style it was an early bloodbath. I was amazed at how quickly the major pieces were gone and each side was left with a queen and a half dozen pawns. Sargon II had the superior pawn structure having no doubled pawns and only one isolated pawn, but Gambiet's queen was still a very potent force. For fifteen moves—a full hour and a half—I watched them waltz back and forth with only the queens moving. Although not a stalemate by repetition technically, it certainly qualified under the spirit of the rule. I have no doubt I could have watched them for the rest of my life and they would still be dancing.

A stalemate. Sargon II finished the mini tournament with a record of 2-1-1, Mychess 2-2-0 and Gambiet '80 1-2-1. Sargon II was the winner, but it left a funny taste in my mouth. The results were so ambiguous. I couldn't play the whole thing all over again. My eyes were failing and my wife was packing her suitcase. Ah, but life is never that simple. Enter yet another chess program with impressive credentials.

Sfinks ($29.95 from William Fink, 1300 SE 3rd Ave., Deerfield Beach, FL 33441) is unique in this field in that it is the only program that plays something besides straight chess. It has four separate options, chess, problem setting, pre-chess and transcendental chess. Pre-chess? In pre-chess, you and your opponent take turns placing the major pieces on the first row. After they are all set you play the game by the usual rules. In transcendental chess the major pieces are placed randomly behind the pawns and the game proceeds as usual. This makes for a very refreshing game for those who are tired of plain computer chess.

Sfinks has superior graphics and if hooked to an amplifier will beep when it makes its move. Like Mychess it comes with its own DOS, which makes it impervious to copying. It has nine levels of play ranging from one second response to two days at level seven. Its tournament level is level eight. This all seemed very similar to Chess Challenger 7 and, in fact, Mr. Finks worked for Fidelity during the developmment of the Challenger series. Sfinks incorporates many of the same ideas, but is definitely a different beast.

Sfinks beat Gambiet '80 twice, though not without some bloodshed, and split a pair of games with Sargon II. Now came the cruncher—the two games with Mychess, but first a word from our arrrgghh department. Remember that both Mychess and Sfinks come with special

DOSes. Since I am borrowing a computer to play these matches (surely you didn't think I was using just one computer!) I have to use what I can get. For this tournament I used a TRS-80 Model I and a TRS-80 Model III. Try as I might, I couldn't get the Model III to accept either Mychess or Sfinks. I was unable to play the two games against each other.

Still unsatisfied with my three way tie, I tried once more for resolution. This time, instead of three minutes per move, everybody plays at his fastest setting—five seconds or less. My chair was swiveling back and forth so rapidly that I could hardly keep up with the games. The machines were making moves before their opponents had finished displaying their moves.

And the results. Mychess and Sfinks beat Gambiet twice which confirms that part of the results. Sargon II, however, beat everybody else. Thus Sargon II, by virtue of a tie coming out of the main tournament and a clear victory in the speed tournament, is the winner.

Mychess probably plays the best chess and if that's all you are interested in then that's the one you should buy. When Programma finishes the changes to include graphics and make Mychess a slick commercial product, it will be the best program around...assuming somebody better doesn't show up. I am a tightwad at heart and I can't see much to recommend Gambiet '80. It plays acceptable chess and has a few nice features, but it just isn't worth the money.

That leaves Sargon II and Sfinks. Sargon II's chess playing ability is comparable to any of them, it is a thoroughly debugged commercial program and is cheaper than Mychess or Gambiet. Sfinks plays good chess and has the non-traditional chess options. Both cost just $29.95. Both have good documentation. Both have good graphics. Sargon II is from a large company with the resources to support it and you if there are problems. Sfinks has a single fellow behind it so there may be less depth, but more personal help. Sargon II won the blitz tournament and has a score of very small factors in its favor. The margin over Sfinks is very slim. Sargon II is the computer chess program of choice and will be the one to which the others compare themselves for some time.

It could very well be that the market for dedicated chess computers is approaching saturation.

Something important should be noted here. When I started this project, back at the dawn of time, Sargon and Chess Challenger were the winners because they played adequate chess and most of their competitors were just plain bad. The gulf was awesome. Last year it was the advanced Sargons and Mychess. The bad programs were few and far between with only the abysmal Microchess still on the scene. The overall quality has improved dramatically. All of the programs in this batch are fine programs and all of their programmers are to be congratulated for a job well done. Gambiet '80 would have destroyed the field in the original tournament.

All of the programs in the field are very close in their playing ability, and that raises another interesting question. Are we approaching the theoretical limit to what can be done on a small computer? I don't think so. Before the end of the decade there will be a program on the TRS-80 that plays 2000 level chess and will make Sargon II look as bad as Sargon made Microchess look. The programs to watch in the near future are Mychess, Sargon and Sfinks. □

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DYNACOMP

Quality software for:*

ATARI — **TRS-80 (Level II)****
PET — **NORTH STAR**
APPLE II Plus — **CP/M Disks/Diskettes**

CARD GAMES

BRIDGE 2.0 (Available for all computers) — **Price: $17.95 Cassette /$21.95 Diskette**
An all-inclusive version of this most popular of card games. The program both BIDS and PLAYS either contract or duplicate bridge. Depending on the contract, your computer opponents will either play the offense OR defense. If you bid too high, the computer will double your contract! BRIDGE 2.0 provides challenging entertainment for advanced players and is an excellent learning tool for the bridge novice. See the software review in 80 Software Critique.

HEARTS 1.5 (Available for all computers) — **Price: $15.95 Cassette /$19.95 Diskette**
An exciting and entertaining computer version of this popular card game. Hearts is a trick-oriented game in which the purpose is not to take any hearts or the queen of spades. Play against two computer opponents who are armed with hard-to-beat playing strategies. HEARTS 1.5 is an ideal game for introducing the uninitiated (your spouse) to computers! See the software review in 80 Software Critique.

STUD POKER (Atari only) — **Price: $11.95 Cassette /$15.95 Diskette**
This is the classic gambler's card game. The computer deals the cards one at a time and you (and the computer) bet on what you see. The computer does not cheat and usually bets the odds. However, it sometimes bluffs! Also included is a five card draw poker betting practice program. This package will run on a 16K ATARI. Color, graphics, sound.

POKER PARTY (Available for all computers) — **Price: $17.95 Cassette /$21.95 Diskette**
POKER PARTY is a draw poker simulation based on the book, POKER, by Oswald Jacoby. This is the most comprehensive version available for microcomputers. The party consists of yourself and six other (computer) players. Each of these players (you will get to know them) has a different personality in the form of a varying propensity to bluff or fold under pressure. Practice with POKER PARTY before going to that expensive game tonight! Apple Cassette and diskette versions require a 32 K (or larger) Apple II

CRIBBAGE 2.0 (TRS-80 only) — **Price: $14.95 Cassette /$18.95 Diskette**
This is simply the best cribbage game around for 8- or 16-resident programs. Has the cribbage player in search of a worthy opponent as well as the novice wishing to improve his game. The graphics are superb and assembly language routines provide rapid execution. See the software review in 80 Software Critique.

THOUGHT PROVOKERS

MANAGEMENT SIMULATOR (Atari, North Star and CP/M only) — **Price: $19.95 Cassette /$23.95 Diskette**
This program is both an excellent teaching tool as well as a stimulating intellectual game. Based upon similar games played at graduate business schools, each player or team controls a company which manufacturers three products. Each player attempts to outperform his competitors by setting selling prices, production volumes, marketing and financing expenditures etc. The most successful firm is the one with the highest stock price when the simulation ends.

FLIGHT SIMULATOR (Available for all computers) — **Price: $17.95 Cassette /$21.95 Diskette**
A realistic and extensive mathematical simulation of take-off, flight and landing. The program solicits aerodynamic equations and the characteristics of a real airfoil. You can practice instrument approaches and navigation using radials and compass headings. The more advanced flyer can also perform loops, half-rolls and similar aerobatic maneuvers. Although the program does not employ graphics, it is exciting and very addictive. See the software review in COMPUTRONICS.

VALDEZ (Available for all computers) — **Price: $15.95 Cassette /$19.95 Diskette**
VALDEZ is a computer version of the superhacker navigation in the Frederik Pohl/Jack Williamson Vaddo Narrows region of Alaska. Included in this simulation is a realistic and extensive 256 × 256 element map, portions of which may be viewed using the ship's alphanumeric radar display. The navigation of the ship itself is accurately modelled mathematically. The simulation also contains a model for the tidal patterns in the region, as well as other traffic-congesting leakers and drifting icebergs! Chart your course from the Gulf of Alaska to Valdez Harbor! See the software review in 80 Software Critique.

BACKGAMMON 2.0 (Atari, North Star and CP/M only) — **Price: $14.95 Cassette /$18.95 Diskette**
This program tests your backgammon skills and will also improve your game. A human can compete against a computer or against another human. The computer can even play itself. Either the human or the computer can double or generate dice rolls. Board positions can be created or saved for replay (North Star and CP/M). BACKGAMMON 2.0 is played in accordance with the official rules of backgammon and is sure to provide many fascinating sessions of backgammon play.

NOMINOES JIGSAW (Atari, Apple and TRS-80 only) — **Price: $16.95 Cassette /$20.95 Diskette**
A jigsaw puzzle on your computer! Consume the puzzle by selecting pieces from a table containing any of 60 different shapes. NOMINOES JIGSAW is a virtuoso programming effort. The graphics are superlative and the puzzle will challenge you with its three levels of difficulty. Scoring is based upon the number of guesses taken and the amount of color of the board set up.

CHESS MASTER (North Star and TRS-80 only) — **Price: $19.95 Cassette /$23.95 Diskette**
This complete and very powerful program provides five levels of play. It includes castling, en passant captures and the promotion of pawns. Additionally, the board may be preset before the start of play, permitting the examination of "book" plays. To maximize execution speed, the program is written in assembly language by SOFTWARE SPECIALISTS of Calabasas, Calif. Full graphics are employed in the TRS-80 version, and two widths of alphanumeric display are provided to accommodate North Star users.

MONARCH (Atari only) — **Price: $11.95 Cassette /$15.95 Diskette**
MONARCH is a fascinating economic simulation requiring you to survive an 8-year term as your nation's leader. You determine the amount of acreage devoted to industrial and agricultural use, how much food to distribute to the populace and how much should be spent on pollution control. You will find that all decisions involve a compromise and that it is not easy to make everyone happy.

CHOMP-O-THE-LLO (Atari only) — **Price: $11.95 Cassette /$15.95 Diskette**
CHOMP-O-THE-LLO! It's really two challenging games at one. CHOMP is similar in concept to NIM, you must bite off part of a cookie, but avoid taking the poisoned portion. OTHELLO is the popular board game set to fully utilize the Atari's graphics capability. It is also very hard to beat! This package will run on a 16K system.

DYNACOMP OFFERS THE FOLLOWING

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- Guaranteed quality
- Fastest delivery
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AND MORE...

STARTREK 3.2 (Available for all computers) — **Price: $11.95 Cassette /$15.95 Diskette**
This is the classic Startrek simulation, but with several new features. For example, the Klingons now shoot at the Enterprise without warning while also attacking starbases in other quadrants. The Klingons also attack with both light and heavy cruisers and move when shot at! If a situation is hectic when the Enterprise is besieged by three heavy cruisers and a starbase S.O.S. is received! The Klingons get even! See the software reviews in A.N.A.L.O.G., 80 Software Critique and Game Merchandising.

BLACK HOLE (Apple only) — **Price: $14.95 Cassette /$18.95 Diskette**
This is an exciting graphical simulation of the problems involved in closely observing a black hole with a space probe. The object is to enter and maintain, for a prescribed time, an orbit close to a small black hole. This is to be achieved without coming to near the anomaly that the tidal stress destroys the probe. Control of the craft is realistically simulated using side jets for rotation and main thrusters for acceleration. This program employs Hi-Res graphics and is educational as well as challenging.

SPACE TILT (Apple only) — **Price: $14.95 Cassette /$18.95 Diskette**
Use the game paddles to tilt the plane of the TV screen to "roll" a ball into a hole in the screen. Sound simple? Not when the hole gets smaller and smaller! A built-in timer allows you to measure your skill against others in this habit-forming action game.

MOVING MAZE (Apple only) — **Price: $10.95 Cassette /$14.95 Diskette**
MOVING MAZE employs the games paddles to direct a puck from one side of a maze to the other. However, the maze is dynamically (and randomly) built and is continually being modified. The objective is to cross the maze without touching (or being hit by) a wall. Scoring is by an elapsed time indicator, and three levels of play are provided

ALPHA FIGHTER (Atari only) — **Price: $14.95 Cassette /$18.95 Diskette**
Two excellent graphics and sound programs in one! ALPHA FIGHTER requires you to destroy the alien starships passing through your sector of the galaxy. ALPHA BASE is in the path of an alien UFO invasion; let five UFO's get by and the game ends. Both games require dye joystick and get progressively more difficult the higher you score!

INTRUDER ALERT (Atari only) — **Price: $16.95 Cassette /$20.95 Diskette**
This is a fast paced graphics game which places you in the middle of the "Dreadstar" having just stolen its plans. The dreads have been alerted and are directed to destroy you at all costs. You must find and enter your ship to escape with the plans. Five levels of difficulty are provided. INTRUDER ALERT requires a joystick and will run on 16K systems.

GIANT SLALOM (Atari only) — **Price: $14.95 Cassette /$18.95 Diskette**
This real-time action game is guaranteed addictive! Use the joystick to control your path through slalom courses consisting of both open and closed gates. Choose from different levels of difficulty, race against other players or simply take practice runs against the clock. GIANT SLALOM will run on 16K systems.

GAMES PACK 1 (Available for all computers) — **Price: $10.95 Cassette /$14.95 Diskette**
GAMES PACK 1 contains the following popular games of BLACKJACK, LUNAR LANDER, CRAPS, HORSERACE, SWITCH and more. These games have been combined into one large program for ease on loading. They are individually accessed by a convenient menu. This collection is worth the price just for the DYNACOMP version of BLACKJACK

GAMES PACK II (Available for all computers) — **Price: $10.95 Cassette /$14.95 Diskette**
GAMES PACK II includes the games CRAZY EIGHTS, JOTTO, ACEY-DUCEY, LIFE, WUMPUS and others. As with GAMES PACK 1, all the games are loaded as one program and are called from a menu. You will particularly enjoy DYNACOMP's version of CRAZY EIGHTS

Why pay $7.95 or more per program when you can buy a DYNACOMP collection for just $10.95?

MOON PROBE (Atari only) — **Price: $11.95 Cassette /$15.95 Diskette**
This is an extremely challenging "lunar lander" program. The user must drop from orbit to land at a predetermined target on the moon's surface. You control the thrust and orientation of your craft and direct the rate of descent and approach angle

ADVENTURE

CRANSTON MANOR ADVENTURE (North Star and CP/M only) — **Price: $21.95 Diskette**
At last! A comprehensive Adventure game for North Star. CRANSTON MANOR ADVENTURE takes you into mysterious CRANSTON MANOR where you attempt to gather fabulous treasures lurking in the manor are wild animals and robots who will not give up the treasures without a fight. The number of rooms in CRANSTON MANOR surpasses descriptions of even more elaborate than the current popular series of Adventure programs, making this game the top in its class. Play can be stopped at any time and the status stored on diskette.

ABOUT DYNACOMP

DYNACOMP is a leading distributor of small system software with sales spanning the world (currently in excess of 40 countries). During the past two years we have greatly enlarged the DYNACOMP product line, but have maintained and improved our high level of quality and customer support. The achievement in quality is apparent from our many repeat customers and the software reviews in such publications as COMPUTRONICS, 80 Software Critique and A.N.A.L.O.G. Our customer support is as close as your phone. It is always friendly. The staff is highly trained and always willing to discuss products or give advice

**ATARI, PET, TRS-80, NORTHSTAR, CP/M and IBM are registered tradenames and/or trademarks*

***TRS-80 diskettes are not supplied with DOS or BASIC*

BUSINESS and UTILITIES

SPELLGARD™ (CP/M only) — Price: $269.95 Disk

SPELLGARD is a revolutionary new product which increases the value of your current word processing system (WORD STAR, MAGIC WAND, ELECTRIC PENCIL, TEXEDIT PLUS and others). Words missed by automatic language SPELLGARD™ (approximately 90% of misreading, spelling and typographical errors) by comparing each word of the document to a dictionary containing upwards of over 20,000 of the most common English words. Words appearing in the text but not found in the dictionary are "flagged" for easy identification and correction. More administrative staff furniture with word processing equipment will be able to use SPELLGARD™ on only a few minutes.

MAIL LIST 2.1 (Apple, Atari and North Star diskette only) — Price: $29.95

Two program (.COMMAND.COM in addition) to store a maximum number of addresses on one diskette (maximum of 1100 per disk) store, more than 2,000 for "double density" systems!). Its many features include alphabetic and zip code sorting, label printing, merging of files, and a simple keyword search system which will search for a variable such as key, city, state or zip code. Mailing lists, Mail List 2.1 will even find and delete duplicate entries. A very valuable program!

TEXT EDITOR II (CP/M only and North Star disk only) — Price: $11.95

Use F1-5 to create and edit form letters and address lists. Form letters are produced by automatically inserting each address in a predetermined position on your letter. TEXT EDITOR II is compatible with MAIL LIST 2.1, which may be used to manage your address files.

FILE and MAIL LIST 2.2 are available as a combined package for $49.95

SORTIT (North Star only) — Price: $29.95 Diskette

SORTIT is a general purpose sort program written in 8080 assembly language. The program will sort sequential data files generated by WORDSTAR or BASIC. Program is extremely versatile and can be used to sort files in a one character string. SORTIT is easily used with files generated by DYNACOMP's MAIL LIST program and is very versatile as its capabilities list all other BASIC data sorting routines.

PERSONAL FINANCE SYSTEM (Atari and North Star only) — Price: $34.95 Diskette

PFS is a package deal menu oriented system consisting of 10 programs designed to organize and simplify your personal finances. Features include a 500 transaction capacity, fast access, 26 optional user codes, data input by month, code or payee, optional printing of reports, checkbook balancing, bar graph plotting and more. Also provided are the Atari diskette as ATARI DOS 2

THE COMMUNICATOR (Atari only) — Price: $9.95 Diskette

The software package contains a menu driven collection of programs for facilitating efficient two-way communications through a full duplex modem (required for use) in one mode of operation you may connect to a data service (e.g., The SOURCE or Micronet) and quickly load data into a file for later examination. In another mode you may connect to a time-share system (remote computer) and then the TYPE command will list any data stored on the computer contents of a command mode file. Another mode allows you to SEND files to REMOTE systems, etc. may be load off line using the support text editor and later "uploaded" to another computer) although there are many smart terminal from Atari BASIC programs may be uploaded. In this, a command file may be built off line and send later as controlling input for a time share system. That is, you can set up your requests of time share commands and programs, and the Atari will request them as needed, later processing. All this adds up to saving both connect time and your time.

DYNACOMP also supplies THE COMMUNICATOR with an Atari 850 modem for a combined price of $219.95. The modem is available separately for $189.95

TEXT EDITOR II (CP/M) — Price: $29.95 Diskette $32.95 Disk

This is the second release version of DYNACOMP's popular TEXT EDITOR I and contains many new features. With TEXT EDITOR II you may build text files in chunks and assemble them for later display. Block of text may be appended, inserted or deleted. Files may be saved on disk diskette at right justified centered format to be later printed by either TEXT EDITOR II or the CP/M ED Facility Tasker. ASCII (CP/M for including BASIC and assembly language programs) may be read by the editor and processed. In fact, this file was written using TEXT EDITOR II and formatted using TEXT EDITOR II. All in all, TEXT EDITOR II is an outstanding, easy to use, but very flexible editing system

COMPRESS (North Star only) — Price: $12.95

COMPRESS—a single disk utility program which removes all unnecessary spaces and (optionally) REMark statements from North Star BASIC programs. The source file is processed one line at a time, then processing very large programs to be compressed using only a small amount of computer memory. Fair compressions of 20-50% are commonly achieved

DISK (North Star only) — Price: $19.95

This handy program allows North Star users to maintain a specialized data base of all files and programs as the stack of disks which accurately accumulates. DISK is easy to set up and use. It will organize your disks in provable efficient stacking of the desired the program

FINDIT (North Star only) — Price: $19.95

This is a three in one program which maintains information accessible by keywords of three types. Personal (eg. last name), Commercial (eg. plumbers) and Reference (eg. magazine articles, record albums, etc.) In addition as keyword searches, there are birthday, anniversary and appointment searches for the personal records and appointment searches for the commercial records. Reference records are accessed by a single keyword as by cross-referencing two or three keywords

GRAFIX ($29.95 Disk) — Price: $34.95 Cassette $18.95 Diskette

This unique program allows you to easily create graphics directly from the keyboard. You "draw" your figure using the program's cursor control commands. Once the figure is made, it is automatically appended to your BASIC program as a string variable. Draw a "happy face" call it HS and then print it from your program using PRINT HS! This is a very easy way to create and save graphics!

EDUCATION

HODGE PODGE (Apple only, 48K Applesoft or Integer BASIC) — Price: $19.95 Cassette $22.95 Diskette

Let HODGE PODGE be your child's little school. Pressing any key on your Apple will result in a different and entertaining "hop. Let HODGE PODGE be your child's little school. Pressing any key on your Apple will result in a different and entertaining "hop from ages 3 to 8 HODGE PODGE is a non-intimidating teaching device which brings a new dimension to the use of computers in education.

TEACHER'S PET (available for all computers) — Price: $11.95 Cassette $15.95 Diskette

This is the first of DYNACOMP's educational packages. Primarily intended for pre-school to grade 2, TEACHER'S PET provides the young student with counting practice, letter word recognition and three levels of math skill exercises

MORSE CODE TRAINER (TRS-80 only) — Price: $12.95 Cassette $16.95 Diskette

MORSE CODE TRAINER is designed to develop and improve your speed and accuracy in deciphering Morse Code. As such MC T is an ideal supplement package for FCC test practice. The code sound is obtained through the earphone jack of the stereo cassette recorder. You may choose the pace of the tones as well as the word rate. Also, various modes of operation are available including number, punctuation and alphabet tests, as well as the keying of your own message. A very effective way to learn code!

STATISTICS and ENGINEERING

DIGITAL FILTER (Available for all computers) — Price: $29.95 Cassette $33.95 Diskette

DIGITAL FILTER is a comprehensive data processing program which permits the user to design his own filter functions or choose from a menu of filter forms. The filter forms are subsequently calculated into user-recursive convolution coefficients which permit rapid data processing. In the replace design mode the shape of the frequency transfer function is specified by directly inserting points along the desired filter curve. In the menu mode, ideal low pass, high pass and bandpass filters may be approximated so varying degrees according to the number of points used in the calculation. These filters may optionally also be smoothed with a Hamming function. In addition, multi-stage Butterworth filters may be selected. Features of DIGITAL FILTER include plotting of the data before and after filtering, as well as display of the chosen filter functions. Also included are convenient data storage, retrieval and editing procedures.

DATA SMOOTHER (Not available for Atari) — Price: $14.95 Cassette $16.95 Diskette

This special data smoothing program will be used to rapidly derive useful information from noisy, random and empirical data which not equally spaced. The software features choice or degree and range of fit, as well as smoothed first and second derivative calculation. Also included is isometric plotting of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers) — Price: $16.95 Cassette $20.95 Diskette

Use this program to examine the frequency spectra of labeled dynamic signals. The program features automatic scaling and plotting of the input data and results. Practical applications include the analysis of vibrational data in fields as diverse as music, communications and forensics

TFA (Transfer Function Analyzer) — Price: $19.95 Cassette $23.95 Diskette

This is a special software package which may be used to evaluate the transfer functions of systems such as hi-fi amplifiers and filters by examining their response to pulsed inputs. TFA is a companion program of FOURIER ANALYZER and many engineering-oriented decked versus log frequency plot as well as data relating features. Windows FOURIER ANALYZER is designed for educational and scientific use. TFA is not warranted for use in nursing.

HARMONIC ANALYZER (Available for all computers) — Price: $34.95 Cassette $40.95 Diskette

HARMONIC ANALYZER was designed for the spectrum analysis of repetitive waveforms. Features include 1000 points sine, sine and cosine coefficients as well as data and spectrum plotting. One particularly unique feature is that the input data need not be equally spaced or in order. The original data is sorted and a cubic spline interpolation is used to create the data file required for FFT algorithm

FOURIER ANALYZER, TFA and HARMONIC ANALYZER may be purchased together for a combined price of $49.95 (three cassettes) and $59.95 (three diskettes)

REGRESSION I (Available for all computers) — Price: $19.95 Cassette $23.95 Diskette

REGRESSION I is a unique and exceptionally versatile one-dimensional least squares "polynomial" curve fitting program. Features include very high accuracy, an automatic degree determination option, an extensive internal library of fitting functions, data editing, automatic data and curve plotting, a statistical analysis including standard deviation, correlation coefficients, etc.) and much more. In addition, new fits may be tried without remetering the data. REGRESSION I is certainly the current most program or any data analysis software library

REGRESSION II (PARAFIT) (Available for all computers) — Price: $39.95 Cassette $43.95 Diskette

PARAFIT is designed to handle those cases in which the parameters are embedded (possibly nonlinearly) in the fitting function. The user simply inserts the functional form, including the parameters (A(1), A(2), etc.) as one or more BASIC statements lines. Data and results may be manipulated and plotted as with REGRESSION I. Use REGRESSION I for polynomial fitting, and PARAFIT for those complicated functions

MULTILINEAR REGRESSION (MLR) (Available for all computers) — Price: $34.95 Cassette $38.95 Diskette

MLR is a professional series package for using the multiple linear regression technique to analyze data. Features include performing the basic regression calculations, this program also provides easy to use data entry, storage, retrieval and editing functions. In addition, there are many options available for displaying the results of the regression including plots of residuals vs variables and data not is limited only by the available memory

REGRESSION I, II and MULTILINEAR REGRESSION may be purchased together for $51.95 (three cassettes) or $63.95 (three diskettes)

ANOVA (Available for all computers) — Price: $39.95 Cassette $43.95 Diskette

In the past the ANOVA (analysis of variance) procedure has been limited to the large mainframe computers. Now DYNACOMP has brought the power of this method to small systems. For those interested with ANOVA, the DYNACOMP software package includes the 1-way, 2-way and N-way procedures. Also provided are the Types 2 & 3 factorial designs. For those unfamiliar with ANOVA, do not worry. The accompanying documentation contains a tutorial (written by a professor in the subject) and serves as an excellent introduction to the subject. Accompanying ANOVA is a support program for loading the data base. Included are several convenient functions for loading data files, transforming, etc.

BASIC SCIENTIFIC SUBROUTINES, Volume 1 (Not available for Atari)

DYNACOMP is the exclusive distributor for the software listed in the book BASIC Scientific Subroutines, Volume I by F. Beckenbach (see the BYTE/McGraw-Hill advertisement in BYTE magazine, January 1981) These subroutines have been supported according to chapter included with each collection in a menu program which selects and demonstrates each subroutine

Collection #1 Chapters 2 and 3 - Data and function plotting, complex variables
Collection #2 Chapter 4 - Matrix and vector operations
Collection #3 Chapters 5 and 6 - Random number generators, curve approximations

Price per collection $14.95 Cassette/$18.95 Diskette

All three collections are available for $39.95 (three cassettes) and $49.95 (three diskettes)

Because this text is a vital part of the documentation, BASIC Scientific Subroutines, Volume I is available from DYNACOMP for $19.95 plus 75¢ postage and handling

ROOTS (Available for all computers) — Price: $16.95 Cassette $16.95 Diskette

In a small, ROOTS simultaneously determines all the zeroes of a polynomial having real coefficients. There is an limit as the degree of the polynomial, yet because the procedure is iterative, it converges relatively very quickly. Obtained guesses are required as input, and the calculated roots are substituted back into the polynomial and the residuals displayed

LOGIC SIMULATOR (Apple only, 48K RAM) — Price: $34.95 Cassette $38.95 Diskette

With LOGIC SIMULATOR you may easily test your complicated digital logic design with respect to given set of inputs to determine how well the circuit will operate. The elements which may be simulated include multiple input AND, OR, NAND, EXOR, EXNOR and NAND gate, as well as inverters, J-K and D flip-flops, and one-shots. The response of the system is available every clock cycle. Inputs may be clocked or with varying clock cycle lengths displacements and delays may be introduced to probe for glitches and race conditions. As the circuit is simulated, the state of the system may be printed out using HIRES graphics. Save your breadboarding until the circuit is checked by LOGIC SIMULATOR.

LOGIC DESIGNER (North Star and CP/M only) — Price: $34.95 Diskette

LOGIC DESIGNER is an exceptional Computer Aided Design (CAD) program. With it you may convert a large and complicated digital truth table (the functional specifications) into a minimized Boolean logic equation. This equation may then be easily converted into a circuit design using either NAND or AND-OR gates. Operationally, LOGIC DESIGNER is composed of a BASIC program which calls on a machine language routine to reduce minimization time. Example: For a 7-variable by 127 line table, the processing time is only two minutes. LOGIC DESIGNER is clearly a fun and powerful tool for building digital circuitry

MISCELLANEOUS

CRYSTALS (Atari only) — $ 9.95 Cassette $13.95 Diskette

A unique algorithm randomly produces fascinating graphics displays accompanied with tones which vary as the patterns are built. No two patterns are the same, and the continued effect of the sound and graphics are mesmerizing. CRYSTALS has been used in local stores to demonstrate the sound and color features of the Atari.

NORTH STAR SOFTWARE EXCHANGE (NSSE) LIBRARY

DYNACOMP now distributor the 21 volume NSSE library. These diskettes each contain many programs and offer an outstanding value for the purchase price. Then should be part of every North Star user's collection. Call or write DYNACOMP for details regarding the contents of the NSSE collection

Price: $9.95 each/ $7.95 each (4 or more)

The complete collection may be purchased for $149.95

AVAILABILITY

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. Unless otherwise specified, all programs will run within 16K program memory space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET, TRS-80 (Level II) and Apple (Applesoft) cassette and diskette as well as North Star single density (double density compatible) diskette. Additionally, most programs can be obtained on standard IBM6 formats 8" CP/M floppy disks for systems running under MBASIC

ORDERING INFORMATION

All orders are processed and shipped within 48 hours. Please enclose payment with order and include the appropriate computer information if ordering by VISA or MasterCard, include all numbers on card

Shipping and Handling Charge:
In ship North America Add $1.50
Outside North America Add 10% (Air Mail)

Delivery:
All orders (including books) are sent First Class

Quantity Discounts:
Deduct 10% when ordering 3 or more programs. Dealer discount schedules are available upon request

5" CP/M Disks:
Add $2.50 to the listed diskette price for each 5" floppy disk (IBM soft sectored CP/M format) Programs run under Microsoft MBASIC or BASIC-80

5¼" CP/M Disks:
All software available as 5" CP/M disks is also available as 5¼" disks, North Star format

Ask for DYNACOMP program at your local software dealer. Write for detailed descriptions of these and other programs from DYNACOMP

DYNACOMP, Inc.
1427 Monroe Avenue
Rochester, New York 14618
24 hour order phone: (716)586-7579 recording
Office phone (9AM-5PM EST): (716)442-8960

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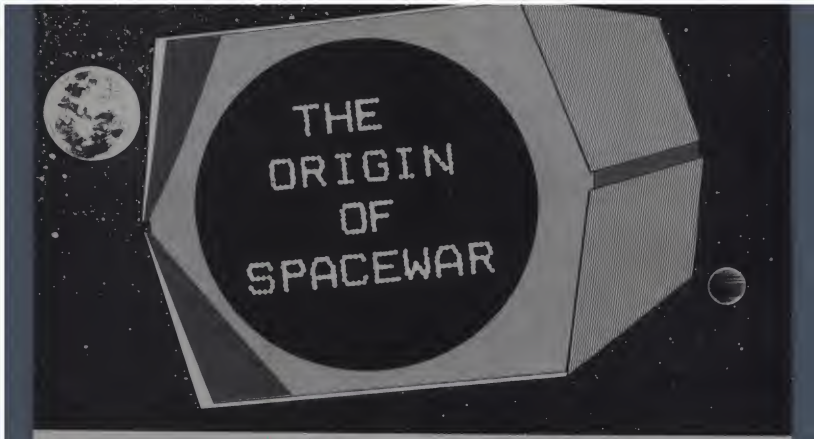
New York State residents please add 7% NYS sales tax

CIRCLE 136 ON READER SERVICE NUMBER



J. M. Graetz

I. BEFORE SPACEWAR!

The Lensman, The Skylark, and the Hingham Institute

It's Kimball Kinnison's fault. And Dick Seaton's. Without the Gray Lensman and the *Skylark of Space* there would be nothing to write about. So most of the blame falls on E. E. Smith, but the Toho Film Studios and the American Research and Development Corp. have something to answer for as well. If Doc Smith had been content designing doughnuts, if American-International Pictures had stuck to beach blanket flicks, if (most of all) General Doriot hadn't waved money in front of Ken Olsen in 1957, the world might yet be free of **Spacewar!**

It all came together in 1961 at the Hingham Institute, a barely-habitable tenement on Hingham Street in Cambridge, MA. Three Institute Fellows were involved: Wayne Wiitanen, mathematician, early music buff, and mountain climber; J. Martin Graetz (which is me), man of no fixed talent who tended to act superior because he was already a Published Author; and Stephen R. (Slug) Russell, specialist in steam trains, trivia, and artificial intelligence. We were all about 25 (the more or less to be the same).

At the time, we were crashing and banging our way through the "Skylark" and "Lensman" novels of Edward E. Smith, PhD, a cereal chemist who wrote with the grace and refinement of a pneumatic drill. These stories are pretty much all of a piece: after some preliminary foofaraw to get everyone's name right, a bunch of overdeveloped Hardy Boys go treking off through the universe to punch out the latest gang of galactic goons, blow up a few planets, kill all kinds of nasty life forms, and just have a heck of a good time.

In a pinch, which is where they usually were, our heroes could be counted on to come up with a complete scientific theory, invent the technology to implement it, build the tools to implement the technology, and produce the (usually) weapons to blow away the baddies, all while being chased in their spaceship hither and thither throughout the trackless wastes of the galaxy (he wrote like that) by assorted Fenachrone, Boskonians, and the World Steel Corporation.

Is that enough to turn the mind to margarine? It is not. In breaks between books, we would be off to one of Boston's seedier cinemas to view the latest trash from Toho. In the days before Mazdas and Minoltas, the Japanese (and occasionally the British and Californians) churned out a steady diet of cinematic junk food of which Rodan and Godzilla are only the best known examples. These movies depended for their effects on high quality modelwork, oceans of rays, beams, explosions and general brouhaha, and the determined avoidance of plot, character, or significance. They were the movie equivalent of *The Skylark of Space*.

If that's the case, we asked ourselves, why doesn't anyone make *Skylark* movies? Hearing no reply (our innocence of current film technology, economics, and copyright laws as enormous), we often passed the time in the Hingham Street common room in deep wishful thought, inventing special effects and sequences for a grand series of space epics that would never see a sound stage. Nonetheless, these books, movies, and bull-sessions established the mind-set that eventually led to **Spacewar!**

When Computers Were Gods

In early 1961 Wayne, Slug, and I, by no coincidence, were all working at Harvard University's Littauer Statistical laboratory. A large part of our jobs was to run statistics computations for various Harvard persons. The agent of choice for this work was an IBM 704.

To a generation whose concept of a computer is founded on the Z80 chip, it may be hard to visualize a 704 or to comprehend the place it held in the public imagination (along with UNIVAC) as the type specimen of what a computer was: a collection of mysterious hulking gray cabinets approachable only through the intercession of The Operator. In the specially built computer room, The Operator set switches, pushed buttons, and examined panels of flashing lights, while his Assistants attended various whirring, clanking, and chattering devices, rushing to and fro with stacks of cryptically-printed paper, decks of weirdly-punched cards,

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Haunted House

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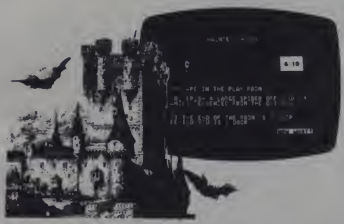
Requires 16K



It's 6:00 pm and you have until midnight to find the secret passageway out of a large rambling HAUNTED HOUSE. During your search you'll encounter skeleton keys, charms, friendly ghosts, and evil spirits. Sound effects add to the eeriness. The layout changes in every game.

Super Invasion

Cassette CS-4006 $19.95
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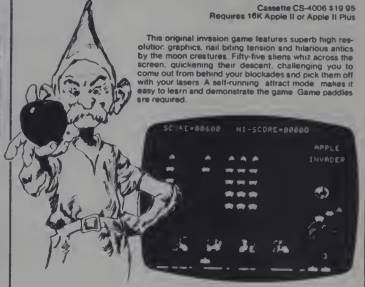

This original invasion game features superb high resolution graphics, nail biting tension and hilarious antics by the moon crestures. Fifty-five aliens whiz across the screen, quickening their descent, challenging you to come out from behind your blockades and pick them off with your lasers. A self-running attract mode makes it easy to learn and demonstrate the game. Game paddles are required.

Outdoor Games

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Treasure Island II. Same game except you have to use a metal detector to find the treasure

Space War

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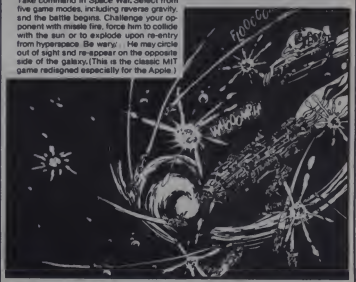
Requires 16K
Apple II or Apple II Plus

Take command in Space War. Select from five game modes, including reverse gravity, and the battle begins. Challenge your opponent with missile fire, force him to collide with the sun or to explode upon re-entry from hyperspace. Be wary... He may circle out of sight and re-appear on the opposite side of the galaxy. (This is the classic MIT game redisigned especially for the Apple.)



Outdoor Games and Haunted House

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and reels of recondite brown ribbon, all to the background hum of The Machine. Add a little incense and a few candles, and you could be forgiven for thinking these were the rites of some oracular shrine.

Everything about the 704, from the inscrutable main frame to the glowing tubes (yes, tubes!) in the glass-walled core memory case, proclaimed that this was a Very Complicated System operated only by Specially Trained Personnel, among whom programmers and other ordinary mortals were not numbered. In short, a computer was something that you simply did not sit down and fool around with.

A Stone's Throw From Olympus

In the summer of 1961 I went to work for Professor Jack B. Dennis, who was then the proprietor of the TX-0, a machine that to me was only slightly less legendary than its ancestor, Whirlwind. The TX-0 was transistorized, and while solid-state computers were beginning to appear on the market, the "Tixo" was the original. Even in 1961 it was acknowledged to be a historically important research facility; many of the programs developed on the TX-0, such as Jack Dennis's MACRO Assembler and Thomas Stockham's FLIT debugging program, were the first of their kind. So the chance to work on this computer was in many ways a rite of passage; it meant that I had joined the ranks of the Real Programmers.

A computer was something that you simply did not sit down and fool around with.

While hardly your average populist Apple, the TX-0 was definitely a step away from the Computer-As-Apollo. Instead of being sealed into its own special chapel, it sat at one end of a typical large, messy MIT research space. With its racks of exposed circuitry, power supplies and meters, and its long, low L-shaped console, the TX-0 looked for all the world like the control room of a suburban pumping station. And the thing of it was, you were expected to *run it yourself*.

So here was the former 704 Operator's Assistant pushing buttons, flipping switches, and pressing keys to make his own programs work. In some ways it was simpler than the 704; for one thing, there wasn't a battery of clanking mechanical monsters. The TX-0's input and output medium was something called a Flexowriter: an all-in-one keyboard, printer, paper-tape reader and punch, that worked like a mule and had a personality to match. There was also a "high-speed" paper tape reader, a Grand Prix whiz that could read programs into memory almost as fast as the cassette-tape reader on a TRS-80.

And the TX-0 had a Scope. Now console-mounted, programmable CRTs were not unheard of at that time but they were generally slow, inflexible, and awkward to program. The TX-0 scope on the other hand, was easy to use; you could generate a useful display with fewer than a dozen instructions. And if that weren't enough, there was a magic wand: the light pen. (The importance of these two devices can't be overemphasized; Ivan Sutherland used the scope and the pen to develop his original "Sketchpad.")

That was the TX-0: the world's first on-line computer, and the training ground for the designers and programmers of later generations of hands-on machines. The first computer bums—hackers—were the products of this training; without it, and them, there would have been no **Spacewar!**

The PDP-1

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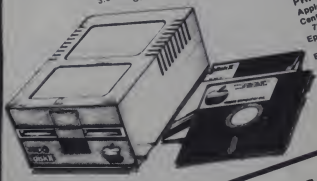

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Tixo's People

The users of the TX-O were a melange of students, staff researchers and professors with not much in common other than their need for large amounts of largely unstructured computer time. The feel of the place, however, was established by the hackers—mostly students, but including a professor or two—whose lives seemed to be organized in 18-bit strings. Many of them worked for Professors John McCarthy and Marvin Minsky in the Artificial Intelligence Group, an odd bunch (even by MIT standards) who seemed convinced that given enough random-access memory and a really fast cycle time you could model the cognitive parts of the brain and hey presto! a real thinking machine. Others worked for Professor Dennis, who presided over the use and development of the TX-O and more or less benignly kept a semblance of order. The man who kept it all running was a soft-spoken, white-haired gentleman, John McKenzie, the chief engineer.

Out of this cloud of computer bums emerged the group that brought **Spacewar!** to the silver (well, light gray) screen: Dan Edwards (AI Group), Lisp specialist; Alan Kotok (TX-O staff), who wrote MIDAS, the successor to MACRO; Peter Samson (AI Group), who made the Tixo and PDP-1 play Bach; and Steve Russell and I.

"You Mean That's All It Does?"

When computers were still marvels, people would flock to watch them at work whenever the opportunity arose. They were usually disappointed. Whirring tapes and clattering card readers can hold one's interest only so long. They just did the same dull thing over and over; besides, they were obviously mechanical—at best, overgrown record changers—and thus not mysterious. The main frame, which did all the marvelous work, just sat there. There was nothing to *see*.

On the other hand, something is always happening on a TV screen, which is why people stare at them for hours. On MIT's annual Open House day, for example, people came to stare for hours at Whirlwind's CRT screen. What did they stare at? Bouncing Ball.

Bouncing Ball may be the very first computer-CRT demonstration program. It didn't do much: a dot appeared at the top of the screen, fell to the bottom and bounced (with a "thok" from the console speaker). It bounced off the sides and floor of the displayed box, gradually losing momentum until it hit the floor and rolled off the screen through a hole in the bottom line. And that's all. Pong was not even an idea in 1960. (Note: Well, maybe not Pong, but something very much like it. Watch these pages.—DHA)

The TX-O's counterpart to Bouncing Ball was the Mouse in the Maze, written by Douglas T. Ross and John E. Ward. Essentially, it was a short cartoon: a stylized mouse searched through a rectangular maze until it found a piece of cheese which it then ate, leaving a few crumbs. You constructed the maze and placed the cheese (or cheeses—you could have more than one) with the light pen. A variation replaced the cheese with a martini; after drinking the first one the mouse would stagger to the next.

Besides the Mouse, the TX-O also had HAX, which displayed changing patterns according to the settings of two console switch registers. Well-chosen settings could produce interesting shapes or arrangements of dots, sometimes accompanied by amusing sounds from the console speaker. The console speaker is a phenomenon whose day seems to have passed. More than just a plaything, for the experienced operator the speaker was a valuable guide to the condition of a running program.)

Finally, there was the inevitable Tic-Tac-Toe, with the user playing the computer. The TX-O version used the Flexowriter rather than the scope. (The game is so simple to analyze that there was even a version for the *off-line* Flexo.)

These four programs pointed the way. Bouncing Ball was a pure demonstration: you pushed the button, and it did all the rest. The mouse was more fun, because you could make it different every time. HAX was a real toy; you could play with it while it was running and make it change on the fly. And Tic-Tac-Toe was an actual game, however simpleminded. The ingredients were there; we just needed an *idea*.

The World's First Toy Computer

For all its homeliness, the TX-O was still very much a god. It took up lots of space, it had to be carefully tended, it took special procedures to start it up and shut it down, and it cost a lot of money to build.

All this changed in the fall of 1961, when the first production-model PDP-1 was installed in the "Kluge Room" next door to the TX-O. It had been anticipated for months; an early brochure announcing the machine (as well as a couple of no-shows called the PDP-2 and PDP-3, in case you were wondering about that) had been circulating in the area for a while. It was clear that the PDP-1 had TX-O genes; the hackers would be right at home.

The -1 would be faster than the Tixo, more compact, and *available*. It was the first computer that did not require one to have an E.E. degree and the patience of Buddha to start it up in the morning; you could turn it on anytime by flipping one switch, and when you were finished, you could turn it off. We had never seen anything like that before.

II. SPACEWAR! BEGUN

The Hingham Institute Study Group On Space Warfare

Long before the PDP-11 was up and running Wayne, Slug, and I had formed a

The TX-O.

sort of ad-hoc committe on what to do with it—it being the Type 30 Precision CRT Display which was scheduled to be installed a couple of months after the computer itself. It was clear from the start that while the Ball and Mouse and HAX were clever and amusing, they really weren't very good as demonstration programs. Why not? Zooming across the galaxy with our Bergenholm Intertialess Drive, the Hingham Institute Study Group on Space Warfare devised its Theory of Computer Toys. A good demonstration program ought to satisfy three criteria:

1) It should *demonstrate*, that is, it should show off as many of the computer's resources as possible, and tax those resources to the limit;

2) Within a consistent framework, it should be interesting, which means that every run should be different;

3) It should involve the onlooker in a pleasurable and active way—in short, it should be a game.

With the Fenachrone hot on our ion track, Wayne said, "Look, you need action and you need some kind of skill level. It should be a game where you have to control things moving around on the scope, like, oh, spaceships. Something like an explorer game, or a race or contest...a fight, maybe?"

"SPACEWAR!" shouted Slug and I, as the last force screen flared into the violet and went down.

The basic rules developed quickly. There would be at least two spaceships, each controlled by a set of console switches ("Gee, it would be neat to have a joystick or something like that..."). The ships would have a supply of rocket fuel and some sort of weapon: a ray or a beam, possibly a missile. For really hopeless situations, a panic button would be nice...hmmm...aha! Hyperspace! (What else, after all, is there?) And that, pretty much, was that.

Figure 1. The Starting Position. The ships are in the centers of diagonally opposite quadrants. The vee of stars at top center is the horns of Taurus. You should be able to pick out the stars of Orion at the left (the bright star just above the wedge-ship is Rigel).

Spacewar! *was an appealing, simple concept, and the hackers were the appealingly simple people to bring it to life.*

The Hackers Meet SPACEWAR!

By the end of summer, 1961, Steve Russell had returned to the Artificial Intelligence Group (he'd worked there before Littauer); consequently, whatever ideas the Study Group came up with were soon circulating among the hackers. **Spacewar!** was an appealing, simple concept, and the hackers were the appealingly simple people to bring it to life. First, however, there was the small matter of software.

The PDP-1 was a no-frills machine at the beginning; except for a few diagnostic and utility routines, there was no program library. In a way this suited the hackers just fine; here was a chance both to improve on TX-0 software and to write new stuff that couldn't have been done before. First, and fairly quickly, MACRO and FLIT were translated from TXish to PDPese. FLIT becoming the first in a continuing line of DDT on-line debugging programs. Steve Piner wrote a text display and editing program called Expensive Typewriter (For a while, "expensive" was a favorite adjective for naming various PDP-1 routines that imitated the functions of more mundane devices. Among them was Peter Samson's E. Planetarium, as we shall see.), another original whose lineage you can trace, if you like, right down to the latest word processors.

With the software taken care of we could write real programs, which is to say toys. Bouncing Ball was successfully converted to PDP-1 use, but HAX, for some reason, was not. But no one really missed it, because we had a brand-new toy invented by Professor Marvin Minsky. The program displayed three dots which proceeded to "interact," weaving various patterns on the scope face. As with HAX, the initializing constants were set in the console switches. Among the patterns were geometric displays, Lissajous-like figures, and "fireworks." Minsky's program title was something like "Tri-Pos: Three-Position Display," but from the beginning we never called it anything but The Minskytron. ("tron" was the In suffix of the early 1960s.)

The classic needle and wedge ship outlines and the opposite-quadrant starting positions were established at this stage, as shown in Figure 1. Acceleration was realistic: it took time to get off the mark, and to slow down you had to reverse the ship and blast in the other direction; the rocket exhaust was a flickering "fiery tail." Rotation, on the other hand, was by something we called "gyros"—a sort of flywheel effect invented to avoid consideration of messy things like moments of inertia. I guess they were really rotational Bergenholms.

It was apparent almost immediately that the featureless background was a liability.

It was hard to gauge relative motion; you couldn't tell if the ships were drifting apart or together when they were moving slowly. What we needed, obviously, were some stars. Russell wrote in a random display of dots, and the quality of play improved. The only thing left, we thought, was hyperspace, and that was on the way. In fact, we'd just begun.

III. SPACEWAR! COMPLETE

Please keep in mind that what follows did not happen in a neat first-one-thing-and-then-the next progression, but rather all at once in a period of about six weeks. When hackers are aroused, anything that can happen will.

The Control Boxes

Spacewar! worked perfectly well from the test word switches on the console, except that the CRT was off to one side, so one player had a visual advantage. More to the point, with two excitable space warriors jammed into a space meant for one reasonably calm operator, damage to the equipment was a constant threat. At the very least, a jittery player could miss the torpedo switch and hit the start lever, obliterating the universe in one big anti-bang. A separate control device was obviously necessary, but joysticks (our original idea) were not readily available in 1962. So Alan Kotok and Robert A. Saunders, who just happened to be members of the Tech Model Railroad Club, trundled off to the TMRC room, scrabbled around the layout for a while to find odd bits of wood, wire, bakelite, and switchboard hardware, and when the hammering and sawing and soldering had ceased, there on the CRT table were the first **Spacewar!** control boxes (Figure 2. These boxes have long since disappeared, but the sketch is a reasonably accurate reconstruction).

First Steps

By the end of 1961, all the elements were in place: a brand new, available computer, a cloud of hackers, tolerant when not actively implicated employers, and an exciting idea. Slug Rusell was getting the heat from everyone to "do something" about **Spacewar!** (I was in a different department at MIT by this time, and Wayne, alas, was one of those unlucky Army Reservists called to active duty during the Berlin Wall panic in October. He never got to participate in developing his own idea.)

Russell, never one to "do something" when there was an alternative, begged off for one reason or another. One of the excuses for not doing it, Slug remembers, was, "Oh, we don't have a sine-cosine routine and gee, I don't know how to write a sine-cosine routine . . ." Then Alan Kotok came back from a trip all the way to Maynard (DEC headquarters) with paper tapes saying "All right, Russell, here's a sine-cosine routine; now what's your excuse?" "Well," says Slug, "I looked around and I didn't find an excuse, so I had to settle down and do some figuring."

With the heavy mathematics in hand, Slug produced the first object-in-motion program in January 1962. This was nothing more than a dot which could accelerate and change direction under switch control. Even without a hardware multiply-divide capability (on the early PDP-1s, anything stiffer than integer addition and subtraction had to be done by subroutine) the computer was clearly not being pushed.

From dot to rocket ship was a surprisingly easy step: "I realized" Slug says, "that I didn't have to worry about the speed of the sine-cosine routine, because there were only two angles involved in each frame—one for each ship. Then the idea of rotating the grid came out." The ship outlines were represented as a series of direction codes starting from the nose of the ship; when the ship was vertical and tail-down, each code digit pointed to one of the five possible adjacent dots that could be displated next. To display the ship at an angle, Russell calculated the appropriate sine and cosine and added them to the original direction code constants, in effect rotating the entire grid. With this method, the ship's angle had to be calculated only once in each display frame. The outline codes were kept in a table so that different shapes could be tried out at will, but this meant that the table had to be searched every frame to generate the outline. As the game developed, this arrangement proved to be a sticking point which we shall see, was neatly solved by Dan Edwards.

By February, the first game was operating. It was a barebones model: just the two ships, a supply of fuel, and a store of "torpedoes"—points of light fired from the nose of the ship. Once launched, a torpedo was a ballistic missile, zooming along until it either hit something (more precisely, until it got within a minimum distance of a ship or another torpedo) or its "time fuse" caused it to self-destruct.

The box is wood with a Bakelite top. The two switches are double-throw; the button is a silent momentary switch. Their functions are as follows:

a. Rotation control. It is pushed to the left to rotate the ship counterclockwise, to the right to rotate clockwise.

b. A two-function control. Pulled back, it is the rocket accelerator; the rocket continues to blast as long as the switch is thrown. Pushed forward, the switch is the hyperspace control, as deseribed below.

c. The torpedo button. It had to be silent so that your opponent could not tell when you were trying to fire. (There was a fixed delay between shots "to allow the torp tubes to cool" and fire was not automatic; you had to keep pushing the button to get off a missile.)

With the control boxes players could sit comfortably apart, each with a clear view of the screen. That, plus the carefully designed layout of the controls, improved one's playing skills considerably, making the game even more fun.

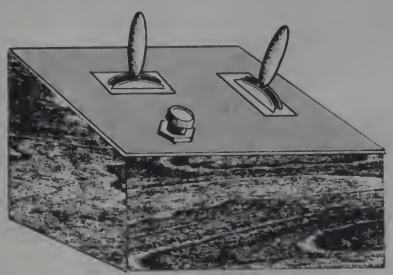

Figure 2. The original control boxes looked something like this. The controls are a) right-left rotation, b) acceleration (pulled back) and hyperspace (pushed forward), and c) torpedo button.

The Stars of the Heavens

One of the forces driving the dedicated hacker is the quest for elegance. It is not sufficient to write programs that work. They must also be "elegant," either in code or in function—both, if possible. An elegant program does its job as fast as possible, or is as compact as possible, or

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Figure 3. The "CBS Opening." The ships turn slightly away from the star and fire a short rocket blast (note the needle-ship's exhaust) to get into a comet-type orbit, then rotate the other way to try shooting torpedoes at the opponent.

Figure 4. "Warp-induced photonic stress emission." The Hyperspace Minskytron signature.

is as clever as possible in taking advantage of the particular features of the machine in which it runs, and (finally) produces its results in an esthetically pleasing form without compromising either the results or operation of the other programs associated with it.

"Peter Samson," recalls Russell, "was offended by my random stars." In other words, while a background of miscellaneous points of light might be all very well for some run-down jerkwater space fleet, it just wouldn't do for the Galactic Patrol. So Peter Samson sat down and wrote "Expensive Planetarium."

Using data from the American Ephemeris and Nautical Almanac, Samson encoded the entire night sky (down to just above fifth magnitude) between 22 1/2° N and 22 1/2° S, thus including most of the familiar constellations. The display can remain fixed or move gradually from right to left, ultimately displaying the entire culinder of stars. The elegance does not stop there. By firing each displayed point the appropriate number of times, Samson was able to produce a display that showed the stars at something close to their actual relative brightness. An attractive demonstration program in its own right, E.P. was "duly admired and inhaled into **Spacewar!**"

The Heavy Star

Up to this point, **Spacewar!** was heavily biased towards motor skills and fast reflexes, with strategy counting for very little. Games tended to become nothing more than wild shootouts. which was exciting but ultimately unrewarding. Some sort of equalizer was called for.

Russell: "Dan Edwards was offended by the plain spaceships, and felt that gravity should be introduced. I pleaded innocence of numerical analysis and other things"—in other words, here's the whitewash brush and there's a section of fence—"so Dan put in the gravity calculations."

The star blazed forth from the center of the screen, its flashing rays a clear warning that it was not to be trifled with.

The star blazed forth from the center of the screen, its flashing rays a clear warning that it was not to be trifled with. Its gravity well encompassed all space; no matter where you were, if you did not move you would be drawn into the sun and destroyed. (As a gesture of good will towards less skillfull or beginning players, a switch option turned annihilation into a sort of hyperspatial translation to the "anti-point," i.e., the four corners of the screen.)

The star did two things. It introduced a player-independent element that the game needed; when speeds were high and space was filled with missiles, it was often sheer luck that kept one from crashing into the star. It also brought the other elements of the game into focus by demanding strategy. In the presence of gravity both ships were affected by something beyond their control, but which a skillful player could use to advantage.

The first result of this new attention to strategy was the opening move in Figure 3, which was quickly dubbed the "CBS opening" because of its eye-like shape. It took a while to learn this maneuver but it soon became the standard opening among experienced players, as it generally produced the most exciting games.

The addition of gravity pushed **Spacewar!** over the edge of flicker-free display. To get back under the limit, Dan Edwards devised an elegant fiddle to speed up the outline display routine.

In Russell's original program, the outline tables were examined and interpreted in every display frame, and essentially redundant operation. Edwards replaced this procedure with an outline "compiler," which examined the tables at the start of a game and compiled a short program to generate the outline for each ship. This dramatically reduced calculation time, restoring the steady display and making room for the last of the original bells and whistles.

Hyperspace

While all this was going on, I was in my secret hideaway (then known as the Electronic Systems Lab) working on the ultimate panic button: hyperspace. The idea was that when everything else failed you could jump into the fourth dimension and disappear. As this would introduce an element of something very like magic into an otherwise rational universe, the use of hyperspace had to be hedged in

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some way. Our ultimate goal was a feature that, while useful, was not entirely reliable. The machinery, we said, would be "the Mark One Hyperfield Generators . . . hadn't done a thorough job of testing . . . rushed them to the fleet" and so on. They'd be good for one or two shots, but would deteriorate rapidly after that. They might not work at all ("It's not *my* fault, Chewie!") or if they did, your chances of coming back out intact were rather less than even. Slug: "It was something you could use, but not something you wanted to use."

The original hyperspace was not that elegant. "MK I unreliability" boiled down to this: you had exactly three jumps. In each jump your ship's co-ordinates were scrambled so that you never knew where you would reappear—it could be in the middle of the sun. You were gone for a discernible period of time, which gave your opponent a bit of a breather, but you came back with your original velocity and direction intact. To jump, you pushed the blast lever forward.

Hyperspace had one cute feature (well, I though it was cute). Do you remember the Minskytron? One of its displays looked very much like a classical Bohr atom, which in those days was an overworked metaphor for anything to do with space and science-fiction. Reasoning that a ship entering hyperspace would cause a local distortion of space-time resulting in a warp-induced photonicstress emission (see how easy this is?), I made the disappearing ship leave behind a short Minskytron signature (Figure 4).

Crocks and Loose Ends

In retrospect, it is remarkable that the original **Spacewar!** managed to include so many features, given the limitations of our PDP-1: 4K words (about 9K bytes) of memory, an instruction cycle time of five microseconds, and a subroutine multiply-divide. It's hardly surprising, then, that we had to let a few unsatisfactory (all right, inelegant) bits go by.

The most irritating of these (and the first to be improved in later versions) was the appropriately-named Crock Explosion. Something dramatic obviously had to happen when a ship was destroyed, but we were dealing with a plain dot-matrix screen. The original control program produced a random-dot burst confined within a small square whose outlines were all too discernible (Figure 5).

This explosion was intended merely as a place-holder until something more plausible could be worked out, but after all the other features had been "inhaled," there wasn't room or time for a fancier calculation.

Similarly, the torpedoes were not quite consistent with the **Spacewar!** universe after the heavy star was in place. The gravity calculations for two ships was as much as the program could handle; there was no time to include half a dozen missiles as well. So the torpedoes were unaffected by the star, with the odd result that you could shoot right through it and hit something on the other side (If you weren't careful getting round the Star, it could be you.) We made the usual excuses . . . mumblemumble photon bombs mumblemumble . . . but no one really cared.

The heavy star itself was not entirely Newtonian. The common tactic of plunging down the gravity well to gain momentum by whipping around the sun (Figure 6) gave you somewhat more energy than you were really entitled to. As this just made the game more interesting, nothing was immediately done to correct it.

IV. AFTER SPACEWAR!

The game was essentially complete by the end of April, 1962. The only further immediate work was to make **Spacewar!** presentable for MIT's annual Science Open House in May. A scoring facility was added so that finite matches could be played, making it easier to limit the time any one person spent at the controls. To provide for the crowds that we (accurately) anticipated, a large screen laboratory CRT was attached to the computer to function as a slave display. Perched on top of a high cabinet, it allowed a roomful of people to watch in relative comfort.

Also in May, the first meeting of DECUS (Digital Equipment Computer Users' Society) was held in Bedford, MA. At that meeting I delivered the first paper on the subject, pretentiously titled "SPACE-WAR! Real-Time Capability of the PDP-1."

Over the summer of 1962, the original Spacewar hackers began to drift away. Alan Kotok and I went to work for Digital. Steve Russell followed John McCarthy to Stanford University. Peter Samson and Bob Saunders stayed in Cambridge for a while, but eventually they too, went west. Dan Edwards remained with the AI group for a few years, then moved to Project MAC. Jack Dennis and the PDP-1 also wound up at Project MAC, which evolved into MIT's Laboratory for Computer Science. Others took up the maintenance and development of **Spacewar!** Program tapes were already showing up all over the country, not only on PDP-1s but on just about any research computer that had a programmable CRT.

A Mystery, Just For Good Measure

Slug tells me that there is a Lost Version of **Spacewar!** There would be, of course.

Figure 5. The Crock Explosion. Nobody's perfect.

Figure 6. A common mid-game flourish—and don't ask about G-forces!

He says the game is pretty much like the original, but the scoring is much more impressive. After each game of a match, cumulative scores are displayed as rows of ships, like a World War II fighter pilot's tally. Slug says he saw this version for a short time on the PDP-1, but never found out who produced it or what became of it.

Twenty Years Later

The original Spacewar PDP-1 was retired in 1975 and put in storage at DEC's Northboro warehouse, where it serves as a parts source for the similar machine now on working display at Digital's Computer Museum in Marlboro, MA. At this writing, DEC engineer Stan Schultz and I are trying to put the original **Spacewar!** back into operating condition. So far, all attempts at finding the original control boxes have been futile; we will probably build replicas (the plastic Atari joysticks we have now got no class).

Dan Edwards still works for the U.S. Government, developing computer security systems. Alan Kotok is still a consulting engineer with DEC. Peter Samson is now director of marketing for Systems Concepts, Inc., in San Francisco. Bob Saunders had gone to Silicon Valley, where is an engineer-programmer for Hewlett-Packard.

Jack Dennis is a Professor of Science in the Electrical Engineering Department at MIT.

John McKenzie, the chief engineer, is retired, but over the past year or so has been helping to restore the TX-0 and PDP-1 to life at the Computer Museum.

And what of the Hingham Institute? Wayne Wiitanen has recently become a Senior Research Scientist at the General Motors Research Laboratory, where he is happily designing eyes for robots. Slug, after various adventures, is now a programmer-analyst for Interactive Data Corp. in Waltham, MA. I am reduced to writing for a living, but tend to act somewhat less superior therefore.

Spacewar! itself has bred a race of noisy, garishly-colored monsters that lurk in dark caverns and infest pizza parlors, eating quaters and offering degenerate pleasures. I think I know a few former hackers who aren't the slightest bit surprised.

Acknowledgements

I was able to reach all of the original **Spacewar!** perpetrators, hackers and Hingham Institute Fellows alike. Not to mention Professors Dennis and Minsky, and John McKenzie. In addition, I am grateful to Marcia Baker, Professor F. J. Corbato, and Professor R. M. Fano, all of MIT, for help with dates and places, and other facts. The help was theirs; any mistakes are mine. □

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Putting Adventure in Adventure Games

Robert Plamondon

As the months go by, the Adventure games get flashier. Some offer color graphics, some have animation, some have realistic combat or fascinating puzzles. It shouldn't be long before they start to talk. There's a lot of glitter in Adventureland.

The glitter is impressive; it's easily good enough to convince you to buy the programs. But after you get them home, and play enough to wear away the freshness, many Adventure games swiftly lose their appeal.

Role-playing games, such as Dungeons and Dragons and Runequest, have been known to hold the players' interest for long periods of time. Role-playing campaigns can continue indefinitely because they deal with the lives of fictitious characters, and a person's life rarely reaches a state where it can be said that he has "won." With new characters being introduced as the old ones die or retire, many role-playing campaigns have lasted for years.

Most designers of Adventure games probably think that they have designed role-playing games. They're wrong. To see why role-playing is important, and where the Adventure games have failed, we need to examine role-playing itself in more detail.

Role-Playing Games

"Role-playing" is a term that may have been coined because "play-acting" doesn't sound very dignified. A role-playing game is a play-acting game; it's as if someone took childhood games like Cowboys and Indians, brought them indoors, added a rules structure and a referee, and turned the players loose to act out the parts of their favorite heroes.

Role-playing games are popular for the same reason that novels and soap operas are popular.

The players (that is, the players who aren't refereeing) have the comparatively simple task of playing a single role—that of an inhabitant of the fantasy world that the referee has created.

This character can be anyone the player wants him to be, from a total alien to a simple "clone" of the player himself. Role-playing does not necessarily mean you are playing the part of someone unlike yourself; it means that you are playing the game from the viewpoint of the character, as opposed to the viewpoint of the player.

The character is assumed to believe that he lives in "the real world." If the player bases his decisions on the character's perception of "the real world," he is role-playing; if he bases them on loopholes in the rules, the experience of a dead character, or the length of time since the game was saved, he is not role-playing. Role-playing games must allow the players to make decisions solely from "game-world" information, and should encourage it wherever possible.

The referee, called the dungeon master, game master, moderator, or "the referee," is in charge of the game. He creates the scenario—a foul dungeon with evil monsters and wondrous treasures, a bandit lair to be leveled, or whatever his imagination dictates. He supervises the creation of the players' characters. He gets things started, plays the parts of all creatures except player characters, settles arguments, and picks up the pieces when the Adventure is over. Being a referee is not an easy task.

As attention is paid to characters and their roles, the campaign becomes more interesting, because people, even fictitious people, are more interesting than flashing cursors or plastic game counters.

Role-playing games are popular for the same reason that novels and soap operas are popular: people like to get involved in other people's lives. That role-playing games usually deal with a heroic and romantic universe doesn't hurt a bit either.

Do's and Don'ts of Role-Playing

There are many things that must be done, and more that must be avoided, to make a successful role-playing campaign.

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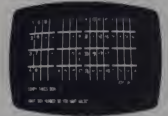
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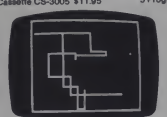

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Adventure, continued...

Features of a Good Campaign:

Realism. Realism in role-playing games means that none of the events breaks the character's "willing suspension of disbelief." Players can accept magic and dragons as part of the background of the fantasy world. They can't accept worlds that turn upside down at night (causing those outside to fall up), outdoor human colonies on the surface of the sun, or personal clues displayed on billboards. Silliness like this makes the game seem empty and trivial, which is not the object most designers have in mind.

Another aspect of realism involves suppressing the egocentric nature of the game. The game exists for the players; the campaign world generally has no significance beyond the game. But it doesn't have to be obvious. It is unrealistic at best, and disturbing at worst, to be involved in campaigns where the game universe revolves around a character's navel. Glaring artificiality is as unacceptable in a game as it is in a movie when the camera pans beyond the false fronts of the houses to show the emptiness behind the facade.

Pace is a missing element in many Adventure games. The game should zip right along, giving new developments, details, and problems as frequently as possible. Most Adventure games grind to a halt every few minutes as the player looks for the one and only tool that will get him past an obstacle.

In live games, the pace can often be increased by screaming, "Get on with it!" at the referee. In computer games, there is no such option.

Flexibility is another big problem. If many problems had more than one solution, there would be more opportunites for original play, or at least the illusion of original play. As it is, most Adventures are an exercise in taking a number of steps in a predetermined order. Going wrong kills, and the game has to be started over, either from scratch, a saved game, or resurrection. This is called "learn by dying."

One way to give more flexibility to a game is to allow items to be used for purposes for which they were not originally intended. Thus, a tree could be cut down with a sword (slowly), or a chair used as a shield. In the traditional role-playing games (that is, those that aren't played on a computer), this is a standard ploy.

Allowing the use of objects for many tasks takes more intricate program design, as the objects have to be defined in more general terms. The most common substitution is to use tools for weapons and vice versa—swords are used as crowbars, wrenches are used as clubs, and rope is used for everything.

Incentive is a vital ingredient. Adventuring is a dangerous business for any character, and there needs to be some incentive to explain his willingness to risk his neck.

Ignoring incentives renders the campaign meaningless; the player has no goal, and just wanders around aimlessly. What fun.

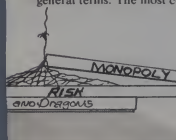
The usual incentive is money. Treasures are placed at strategic points along the character's route, and they are supposed to stimulate his avarice enough to make him enjoy the game.

Treasure by itself is meaningless, however. If the character can't do anything useful with it, it's just so much dead weight. Most successful games, such as Risk, Monopoly, and Dungeons and Dragons, recognize this, and make their "treasures" useful. In Monopoly, money is useful for purchases and expenses; in Risk money provides armies; and in D&D, money can buy anthing, including love (well, love potions).

Character Growth is beyond the scope of most Adventure games, but should not be overlooked as a possible feature. "Character growth" describes an increase in the abilities or power of a character—as opposed to an increase in wealth and possessions. In traditional role-playing games, growth occurs in the form of increased strength—both in arms and magic, as well as connections in high places—the acquisition of land, armies, public office, trading fleets, and, most important of all, reputation and knowledge.

Character Growth is beyond the scope of most Adventure games, but should not be overlooked as a possible feature.

A game in which the characters experience true growth is very rewarding. The player is obviously getting somewhere with his character when he becomes an important local figure. The flavor of the game changes as a character becomes powerful; what was a life-and-death matter at the beginning of his career becomes a trifle, and bigger and nastier problems appear to challenge his abilities.



Features of Poor Campaigns

Too many puzzles. The worst flaw of Adventure games is that they are puzzle games, and nothing else. The player tries to solve a series of puzzles, and proceeds a little further each time he figures one out.

The problem is that puzzles aren't very exciting. They are often interesting, and somethimes fascinating, but they're almost never thrilling. Excitement is one of the keys to an enjoyable game, and is an element in which Adventure games are woefully deficient. What is worse is that they tend to replace excitement with frustration; you no sooner solve one puzzle than you are presented with another.

Adventure games need to present the player with a series of problems to be solved, otherwise there is no challenge. But there are more elegant ways of achieving this than with a puzzle string.

Most of the difference between the puzzle game and the problem-solving game is that the puzzle game presents you with obstacles that are easy to overcome if you know the trick and place the difficulty in finding the trick. Once the situation to a puzzle is known, implementing it is trivial.

Other games make the execution of the solution difficult. It may be obvious that the characters will have to build a bridge to cross a river. The knowledge isn't enough; they actually have to build the bridge—and any number of things may go wrong.

The problem lies in the realization that it is easier to program simple, deterministic solutions (such as, "if he has the axe, he can carve a canoe"), than to deal with the more complex case, which depends on circumstances, method, and perhaps luck. This fact leads directly to puzzle games; not because puzzle games are superior, but because they are easy to program.

The Puppet Fallacy. A deadly sin of Adventure games is the statement. "I'll be your puppet in this adventure. You type in any two-word English sentence, and I will follow your advice like the

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Adventure, continued...

zombie I am."—not in those words, of course.

The phrase, "I'll be your puppet" manages to destroy the possibility of role-playing in four short words. It emphasizes the fact that you're playing a game, rather than embarking on an adventure, it reduces the concept of role-playing to the manipulation of an inanimate object, and trivializes the entire game.

This is often compounded by having the game narrated in the first person, with frequent queries of, "what shall I do?"—which often provoke an obscene response.

Since most Adventures provide no opportunity for character creation, the best they can do is project the player into the campaign. The easy way to do this is to describe everything in the second person; that is, to preface descriptions with, "you see..." and prompt input with, "what do you want to do?"

This does much to create the illusion of the player being inside the Adventure, which puts it on a more personal level than the "puppet" format, which gives the impression that the adventurer is a zombie who completes an instruction, jerks to a halt, and waits for the next command.

The "Monty Haul" Campaign. There are two facets to the Monty Haul campaign, which is named after the host of the TV show "Let's Make a Deal."

The first is the assumption that, if some treasure is a good incentive, more is better. This leads to campaigns in which the weight of the jewels found is too much for the adventurers carry, or where world-destroying weapons are guarded by rats, freeing the large monsters to protect the *powerful* stuff.

This is comparable to the phenomenon of score inflation in pinball. It used to be that the least significant targets were only one or two points, and scores of four or five thousand were fantastic. Now the minimum score seems to be around a hundred, which means that there are two gratuitous zeroes tacked on the end of an honest pinball score.

People are not fooled by this kind of inflation for long. Worse yet, you eventually exhaust their ability to conceive of large numbers. A score of a billion is meaningless, other than to give the impression of hugeness. An adventurer with world-shattering magic is rarely a person; he is a walking equipment list, and the equipment is too mind-boggling to be used seriously or well.

The second facet of the Monty Haul syndrome is the choice of "Door Number One, Door Number Two, or Door Number Three." Many game designers delight in putting buttons to push, levers to pull, and other items to manipulate, with no clue to their function. The idea is that risking you character's life for no apparent purpose is fun.

The proper method of dealing with machines of unknown (but probably dangerous) function is to leave them alone, as any eight-year-old can tell you. If the Adventure forces you to push the buttons, or whatever, then the correct response is to return the program to the manufacturer and ask for a refund, since the Adventure is obviously defective.

If the purpose of the machine is known, then it is something less than perverse to confront the adventurer with unlabeled controls. For example, caterpillar tractors have many control levers which are often unlabeled. Trying to control the motion of a bulldozer would require some experimentation with the controls. On the other hand, the levers on a bulldozer won't cause steel doors to close in another building, or launch ICBMs—they affect only the bulldozer. Controls should be limited to reasonable functions.

An adventurer with world-shattering magic is rarely a person.

The Gilded Hole Campaign. This is the bane of Dungeons and Dragons campaigns. A common misinterpretation of D&D is that it consists of killing the monsters and taking their treasure. Why do the adventurers do this? So they can afford more equipment to kill more monsters and take their treasure, etc. I'm not saying that all D&D campaigns necessarily fall into this trap—mine certainly don't—but it is one of the favorite misinterpretations.

In the Gilded Hole campaign, the only places of any importance are places where monsters can be killed (and their treasure taken), and places to sell the loot. Many campaigns consist solely of dungeons and general stores, with all other elements of a complete fantasy world discarded as irrelevant.

The problem with this approach is that the endless struggle becomes boring and repetitive. After a while the monsters begin to look alike, and treasure fails to warm the players' greedy hearts. The Gilded Hole expeditions are simply too much alike to keep the players' interest alive.

Besides, the treasure is supposed to be used as an incentive for action. In the Gilded Hole campaign, treasure is necessary for continued action, but not useful for any other purpose. All you can do with the loot is finance another expedition. No true incentive exists.

If the money could be used to buy mansions, castles, or titles, or finance commercial ventures and private armies, the campaign would retain its appeal. It would also expand beyond the confines of the dungeon and general store, as the players tried to manage their other holdings.

The Gilded Hole is an excercise in futility, since the struggle gets you nothing but more struggle. There are several Gilded Hole Adventures, some very well written, but they all suffer from their own limited scope.

Gilded Hole campaigns link up naturally with Monty Haul campaigns, and the result is a very flashy, very poor game. The flashiness is enough to make it sell, but not enough to make up for the flaws.

Cuteness. It is difficult to enjoy an Adventure game in which the designer decided to be cute. Cuteness is generally an attempt at humor that failed. It destroys realism, crushes any semblance of significance and has a tendency to cause the player to sneer at the Adventure. Genuine humor is rarely harmful, but it's also rarely found. If a joke is called "cute," "silly," or "clever," by players, it should be buried as soon as possible.

Opportunities for Role-Playing

Opportunities for role-playing are rare in most Adventure games. All contacts with other creatures are superficial; if they speak, they just read off a pre-recorded speech, and if they fight, they attack with mindless ferocity.

Role-playing can be exercised anytime there is a decision to be made, since the

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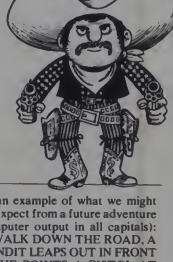
role-player will try to make it in character. Still, most Adventure games have only one solution to each problem; there is no room for originality or personalization. The puzzle game and the role-playing game are mutually exclusive, since in the first the task is to find *the* solution, while in the other the task is to find a solution that suits the role you are playing. Puzzle games force the players to abandon their roles if they want to win, and give little room in which to play a role in any event. Role-playing games generally lack the interlocking network of puzzles, and concentrate on the characters and their careers.

Conversation with Creatures in the scenario has been avoided in Adventure games, perhaps because it's "too hard."

That conversation is difficult in the format of two-word commands is obvious, and the equally obvious solution is to abandon the use of two-word commands, at least in conversation.



Here is an example of what we might be able to expect from a future adventure game (computer output in all capitals):
AS YOU WALK DOWN THE ROAD, A HUGE BANDIT LEAPS OUT IN FRONT OF YOU. HE POINTS A PISTOL AT YOUR STOMACH AND SAYS WITH A GRIN, "STAND AND DELIVER."
"How much do you want?"
(Note: quotation marks tell the program that the character is speaking)
HIS GRIN WIDENS. "I AM NOT A GREEDY MAN," SAYS HE. "BUT I'LL TAKE WHAT'S IN YOUR PURSE, AND THAT FANCY DAGGER, TOO, AND LEAVE YOU THE REST."
"Just the dagger"
"I'LL HAVE BOTH, IF YOU PLEASE, AND BE QUICK ABOUT IT."
Give purse
(Note: the lack of quotation marks indicates a command)
"MUCH OBLIGED, NOW THE DAGGER."
Stab thief
WITH A STRANGLED MOAN, THE BANDIT FALLS TO THE GROUND.

Role-playing can be exercised anytime there is a decision to be made, since the role-player will try to make it in character.

There is already a program which does a good job of providing realistic responses to English sentences; it is "Eliza," which is a convincing imitation psychotherapist. The program only recognizes a limited range of inputs, but that's nothing new to Adventure games. The Eliza algorithm, or a similar one, should be well suited to conversations in Adventure games.

Watch the Role-Playing Games

Adventure games have a distinct resemblance to role-playing campaigns run by relative novices. Many of the advanced concepts, such as the nature of realism, character development, and other role-playing philosophy are either poorly done or ignored completely.

This probably stems from the program designers' lack of contact with the role-playing community. All aspects of role-playing games are examined, criticized, and altered with surprising regularity by the faithful.

Adventure game designers, and the players as well, would benefit from listening to these discussions. Fortunately, there is no need to find a cave full of game fanatics to hear the news. There are several excellent publications that deal with the practice and philosophy of role-playing. The philosophy of role-playing is a more practical topic than it would seem at first glance; handling a role-playing game well requires that you understand what you're trying to do before you start putting rules together.

Conclusions

Although there is trouble in Adventureland, there is a great deal of potential, as well. Many of the ideas needed for a second generation of Adventure games have already been worked out, and others will be developed as Adventure games progress. The excitement of role-playing games and the abilities of the microprocessor are too complementary to remain separate for long.

So, with high hopes, I keep my silicon sword and my CTRL-Reset shield ready for my next excursion into Adventureland.

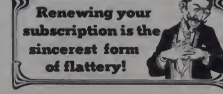
Some Role-Playing Publications

Alarums & Excursions is a monthly Amateur Press Association Magazine (APA or apazine), which is a collection of uncut contributions from anyone who wants to submit a stencil. The quality varies from contributor to contributor, and from issue to issue, and the legibility is often poor, but this is one of the best sources for ideas in role-playing games. Price is $1.50 plus postage, which costs $0.83 book rate, or $1.40 UPS. Send a check to Lee, and she'll send you *A&E* as long as your money holds out, and refund any remainder. Write to: Lee Gold, 3965 Alla Rd., Los Angeles, CA 90066.

Different Worlds is a bimonthly professional magazine which covers the entire field, with a leaning toward the philosophy of role-playing. Many of the better apazine essays appear in *DW* eventually, and it contains much original material as well. *DW* costs $2.50 per issue, and $10.50 for a six-issue (one year) subscription. Write to: *Different Worlds*, P.O. Box 6302, Albany, CA 94706.

Dragon is a monthly professional magazine, which deals mostly with role-playing games, but has pieces on other games as well. It covers the whole field, but is deficient in articles on role-playing philosophy. *Dragon* costs $3.00 per issue or $24 per year. Write to: *Dragon Magazine*, P.O. Box 110, Lake Geneva, WI 53147.

The Wild Hunt is a monthly apazine which is about half as thick as *Alarums & Excursions*, and is offset printed rather than mimeographed, which improves its legibility immensely. *TWH* is more concerned with role-playing philosophy than *A&E*, and the average quality may be a bit higher. It costs $1.50 plus postage, which varies from issue to issue. Send Mark a check, and he'll send you *TWH* as long as the money lasts. Write to: Mark Swanson, 40 Bow St., Arlington, MA 02174. □



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About this same time, I had just finished several weeks of lunch hours (half hours if my boss is reading this) doing some fantastic arm chair spelunking. Yes, I had become hooked on exploring that colossal underground cave where magic is said to work and others had found fortunes in treasure and gold!

My large, friendly computer at work had been my eyes and hands guiding me past giant snake and dragon through scores of rooms deep underground. I even tricked a troll. I was able to retrieve 15 magnificent treasures bringing them to the surface to be mine forever! Once in that cave it wouldn't let me give up, as I soon discovered, until finally, finally, many lost lunch hours (half hours if my boss is still reading this) later, every corner and dead end had been explored, a map of the cave was in hand and I had solved the original "Adventure."

Then a thought came to mind. I promptly dismissed it as absurd. But the thought kept haunting me until it became a chal-

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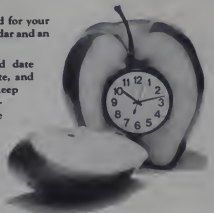

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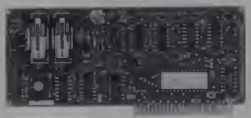

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lenge. Could this tiny little 32K computer with no disk which I now owned—could it possibly handle "Adventure"? Would the original Crowther and Woods Adventure program fit into 32,768 bytes of memory? I had seen several versions of this program advertised which required at least one disk drive and 32K or more of memory, but none for my little one. Was my little computer really equal to the task, or was I just fooling myself?

The challenge lay before me: get "Adventure" running in Basic on an Atari 800 computer with no disk and only 32K bytes of memory. Little did I realize what I was getting myself into when I accepted this challenge. A challenge that would certainly tell me if this new little addition to the family was really a giant in disguise!

Have you ever spent your whole summer beside the swimming pool out back, with the tops of your hands, shoulders and knees burning up from the sun, never once getting your swimming suit wet? No? Well then, you have never spent the summer trying to cram "Adventure—messages and all—into 32K of RAM. I did. And to spare you the gruesome details, suffice it to say that I accepted the challenge and won! Just as it was time to close down the pool for the winter, "Adventure" was running on my big computer (never again to be called "little").

The messages and vocabulary were not as extensive as in the original, but they were there, along with the rooms in various colors (except the "all alike" maze where passages and dead ends were all black). Almost everything from the original "Adventure" was included.

Now I know what you just said. You said, "How did he do it?" Well if you didn't say that then you should have, because that's the purpose of this article. As a result of my programming effort, as well as missing out on a whole season of swimming, I learned many techniques for efficient use of memory in Atari Basic. I am going to pass these along so that you will never need to worry about the swimming season passing you by.

Although my examples and techniques refer to Apple Basic and "Adventure" type programs in particular, most of them can be applied to any computer and to programming in general. Why purchase 48K of memory and two disk drives, when in many instances 32K or less of memory is all you really need. Why bemoan the fact that the latest "GLOP" game from the pages of this magazine requires 10K of RAM and your computer only has 8K. Apply a couple of the techniques that I am about to describe and you can probably get the program into 7K or less without losing a single feature!

REMarks

Although I realize that adequate documentation is often lacking in many programs today, when memory is at a premium, REMark statements must be sacrificed. A remark N characters long including imbedded blanks) occupies N+3 bytes if on the same line as another statement and N+6 bytes on a line by itself. Thus, REM's interspersed throughout a large program can waste a significant amount of memory.

An alternative which I use successfully, is to keep the remarks separately on paper, refering to the line numbers in the program. As the program is developed and changed, these remarks are also updated. Then, when the program is finished, a good set of documentation is already available. Also, by maintaining an up-to-date set of remarks, I found I was able to debug the program much more quickly. I estimate I saved about 1000 bytes of memory by eliminating the REMark statements from my "Adventure."

Line Numbers

When a new line (with a new line number) is added to a program, 6 bytes of memory are required by the new line. When that same Basic statement is added to an already existing line, only 3 additional bytes are required. Therefore, 3 bytes of memory are saved each time a new statement is added to a line which already exists. (Multiple statements per line are, of course, separated by colons.) To illustrate the savings that can result, in my version of "Adventure" there are about 720 individual Basic statements (not including DATA statements) but only 325 line numbers. This saves (720-325)*3 or 1185 bytes of memory.

Having written programs for many years using one statement per line, I was a little apprehensive about how difficult multiple statements per line would make program legibility and debugging. However, I found I had no trouble whatsoever reading the program and working with it, even though the Basic statements were packed very tightly.

Putting more than one statement on a line can cause problems if one is not careful, especially in a Basic that contains no ELSE capability. Consider the following example:

```
100 SUM=0
110 FOR I=1 TO 10
120 IF A(I)>0 THEN SUM=SUM+A
    (I)

130 NEXT I
140 PRINT SUM
```

One would be tempted to rewrite this sequence all on one line (with one line number) as follows:

```
100 SUM=0: FOR I=1 To 10: IF
A(I)>0 THEN SUM=SUM+A(I):
  NEXT I: PRINT SUM
```

However, this puts the NEXT and PRINT statements under the control of the IF, causing them to be executed only when the IF is true. This will produce incorrect results. The proper way to consolidate these statements is:

```
100 SUM=0: FOR I=1 TO 10: IF
A(I)>0 THEN SUM=SUM+A(I)
130 NEXT I: PRINT SUM
```

Statements after an IF should be placed at the front of the following statement, or on a line by themselves if the following statement has a branch to it from elsewhere in the program. Of course if the statements after the IF clause are to be executed only when the IF condition is true, then they must be left on the same line as the IF statement.

Here is another example which sets X to 10 or 20 depending on the value of L:

```
100 IF L=R THEN 400
200 X=10
300 GOTO 1000
400 X=20
500 GOTO 1000
```

This section of the program can be neatly condensed into two lines as follows (eliminating one GOTO and saving 27 bytes):

```
100 X=10: IF L=R THEN X=20
200 GOTO 1000
```

Again, the GOTO 1000 must be placed on a separate line so it does not fall under the control of the IF statement.

It may not be obvious what will happen when some statements in Atari Basic are imbedded in the middle of a multi-statement line. Figure 1 lists these statements with an explanation of what happens to statements which follow each of them on the same line.

Statement	Statements following on same line
DATA	Never executed
DIM	Always executed
END	Never executed
FOR	Always executed
GOSUB	Executed upon RETURN
GOTO	Never executed
IF . . . THEN	Executed on condition true Never executed on condition false
LIST	Always executed
NEXT	Executed when FOR loop is finished
ON aexp GOTO lineno-list	Executed if aexp is less than 1 or greater than the number of line numbers in the lineno-list
ON aexp GOSUB lineno-list	Executed if aexp is less than 1 or greater than the number of line numbers in the lineno-list, otherwise executed upon return from the subroutine
POP	Always executed
REM	Never executed—treated as part of the REMark
RETURN	Never executed
RUN	Never executed
STOP	Never executed
TRAP	Always executed

Figure 1.

Make a similar table for your Basic by trying out each statement in a small test program. Then keep this table handy for reference when you are optimizing a large program.

Another way to eliminate line numbers is by inserting a NOT in front of an IF condition. For example:

```
100 IF A=1 AND B>5 THEN 130
110 B=B-1
120 GOTO 1000
130 PRINT
```

may be rewritten on two lines (saving 11 bytes) as follows:

```
100 IF NOT(A=1 AND B>5) THEN
B=B-1: GOTO 1000
130 PRINT
```

Here is a different example that may occur in a program:

```
90 ON X GOTO 100,200,300,400
100 T=0: GOTO 1000
```

These two lines may be condensed onto one line:

```
90 ON X-1 GOTO 200,300,400: T=0:
GOTO 1000
```

eliminating line 100 and saving three bytes.

There are many other ways that multiple statements may be squeezed onto one line in order to save memory. A program that does not already do this can probably be reduced to 75% or 50% of its original line numbers. Keep in mind however, that a branch to a statement from elsewhere in the program requires that statement to be at the beginning of a line. Also, in Atari Basic this technique is limited by the length of a logical line which is equal to a maximum of three physical lines or 120 characters. Greater savings can be obtained using Basics which allow more characters per logical line.

Don't Use Constants!

One of the biggest memory wasters in Atari Basic is the use of constants. Each occurrence of a numeric constant or a line number in a Basic statement is replaced by one byte pointing to the memory location where the value of that constant is stored. This value in memory is stored in internal binary form and occupies an additional 6 bytes regardless of the size of the constant. Therefore, each use of a numeric constant or line number in a statement requires 7 bytes of memory. This method of storing numeric constants is what would be expected. Now for the bad news. Since Basic is an interpreter (that is, every statement is kept in memory in almost its original form and decoded each time the statement is executed), when it encounters a constant in a new statement being entered in, it has no way of knowing if that constant was used before. Therefore, it just goes ahead and converts into internal binary form and stores it in memory again using another 7 bytes.

Now, suppose a large program uses the constant 0 (zero) 50 times. Then that one constant occupies 7 times 50 or 350 bytes of memory! Likewise, suppose line number 100 is referenced in GOTO and IF...THEN statements 50 times throughout a program. That one line number also occupies 350 bytes of memory. So we have 700 bytes of memory being used to store the two values 0 and 100. Wouldn't it be nice if each new use of the same constant or line number would point to the memory locations where that value was stored the first time?

Fortunately, there is a way to make that happen; by the use of variables in place of numeric constants and line numbers. The first time a variable is used in a statement four things happen:

1. The variable name is placed in a table in memory called the VNT (Variable Name Table).

2. Six bytes of memory are allocated to store the value of the variable.

3. Two additional bytes are stored in the VNT which point to the value of the variable in memory.

4. One byte is placed in the Basic statement in place of the variable name. This byte points to the VNT.

Thus N+6+2+1 or N+9 bytes of memory are used to store the first occurrence of a variable name (where N is the number of characters in the name of the variable).

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Now the memory-saving aspect of this method comes into play with the second, third, etc. time the variable name is used. Each subsequent use causes only 1 additional byte of memory to be allocated: the byte in the Basic statement that points to the VNT. Unlike when a constant is used, the 6 bytes of memory to store the value is not allocated over and over again.

To use this method of replacing constants with variables, one other item must be considered. The variable being used must be initialized with the value of the constant it represents. The most efficient way to do this is with READ and DATA statements at the beginning of the program. In an initialization section, values are read in for all the variables which are being used to replace numeric constants and line numbers.

A good rule of thumb to use in deciding whether or not to replace a particular numeric constant or line number with a variable is the following: If the same numeric constant or line number is used four or more times in a program, memory will be saved by converting it to a variable. If used three or fewer times, leave it in its original form.

Of course, the more characters there are in the variable name and in the constant, the more memory will be used in the VNT (to store the variable name) and in the READ/DATA statements. However, the break between three and four occurrences seems to work in most cases.

Now you are probably saying to yourself, "How can I possibly make any sense out of my program if I convert all the constants and line numbers to variable names?" And I agree. If you can't distinguish between the constants and actual variables, then reading the program listing becomes difficult.

Therefore, decide on a pattern for variable names which will be used to represent numeric constants and line numbers in the program and stick to this pattern. An example of what I use is found in Figure 2.

Constants	Variable Names
0	Z
1 to 9	A to I
10 to 19	A0 to A9
20 to 29	B0 to B9
.	.
.	.
90 to 99	10 to 19
100 to 109	A00 to A09
.	.
.	.
etc.	etc.

Figure 2.

Then for real variables which do actually vary, I use the names J through Y and names that contain all letters (such as AA, AB, QX, ZZ, etc.). This way I can always distinguish constants from variables. If the program uses negative and decimal constants, then establish a pattern for them also.

Figure 3 is example of a program segment before and after the constant-to-variable surgery has taken place.

Note, when a statement number on an IF...THEN is changed to a variable, a GOTO must be inserted (see line 60 in Figure 3). Other than this one exception, any place a numeric constant or line number can be used in an Atari Basic statement, a variable can be substituted. Also note line 40; even the dimensions in an array can be made variables, thus saving the memory that would be used to store the constant dimensions.

Is it really worth the trouble to convert most of the constants and line numbers in a program into variables? In my "Adventure" program, I changed 58 constants and line numbers to variables and saved over 3500 bytes! This represents 12% of the free memory on a 32K Atari system, so the effort certainly paid off. The maximum number of variable names allowed in a single program in Atari Basic is 128. This is as big as the VNT can get.

Therefore, start with the numeric constants and line numbers that are used most often since these will result in the greatest savings. Also, instead of converting constants which are not used very often, consider that GOTO 9 can be changed to GOTO D+E. This will save changing the constant 9 into a variable if D and E are already defined to be 4 and 5 respectively. The constant 9 requires 7 bytes whereas D+E requires only 3, a saving of 4 bytes of memory. Use this technique of combining variables to replace constants that occur three or fewer times in a program.

As can be seen, substitution of variables for oft-used numeric constants and line numbers can result in a substantial increase in memory available in a program.

Before	After
	10 READ A,A0,A00,B50,F,I0,Z
	20 DATA 1,10,100,250,6,90,0
40 DIM COUNT (100)	40 DIM COUNT (A00)
50 FOR J=1 TO 100	50 FOR J=A TO A00
60 IF INT(RND(0)*10)+1>6 THEN 90	60 IF INT(RND(Z)*A0)+A>F THEN GOTO 10
70 GOSUB 250	70 GOSUB B50
80 COUNT(J)=COUNT(J)+1	80 COUNT(J)=COUNT(J)+A
90 NEXT J	90 NEXT J

Figure 3.

Numeric Arrays

How much memory will the following statement use:

10 DIM A(100), B(100), C(100), D(100), E(100)

If your answer is 500 bytes, you are not even close. The above dimension statement will require over 3000 bytes of memory. Yes, 3000! Why? As we discussed earlier, numbers in Atari Basic are kept in memory in internal binary form occupying 6 bytes each. Therefore, each of the above arrays uses 100 times 7 bytes of memory apiece, and 5 of them will take 100 times 6 times 5 or 3000 bytes. When the memory space is tight, there are two rules to observe in using numeric arrays: 1. Keep their dimensions as small as possible. 2. Eliminate them whenever possible.

There are several ways to eliminate numeric arrays. I will mention two of them: Convert them to strings, and store numeric data in DATA statements and access it with READ statements each time the data is required.

In Atari Basic, strings must be dimensioned. In the statement:

10 DIM R$(100), R(100)

R as we now know occupies 600 bytes, but R$ occupies only 100 because it is a string 100 characters long. Now suppose in an "Adventure" program there are 100 rooms and the program keeps track of which rooms have been visited and which have not. Each element of R(100) would represent a room. R would be initialized to all zeros and when a room was entered, the corresponding element of R would be set to 1. Since each element of R holds only a 0 or 1, this same function can be accomplished with string R$(100) using approximately one-sixth the memory. First R$ would be initialized to all "N" characters (representing "No, the room has not been entered") as follows:

100 FOR I=1 TO 100: R$(I,I)="N": NEXT I

(Note in Atari Basic, R$(i,j) represents the substring from R$ starting with character i and ending with character j. Therefore, R$(i,i) represents the ith character of string R$.) Then when room

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number I is entered, R$(I,I) would be set to "Y" (indicating "Yes, the room has been entered"). At the end of the game, the number of rooms visited would be counted as follows:

```
1000 SUM=0: FOR I=1 TO 100: IF
R$(I,I)="Y" THEN SUM=SUM+1
1010 NEXT I
```

Of course, if a numeric array is needed to store many different values, this method will not work. However, for storing just a few different values, try using a string instead of a numeric array and substitute different characters for the various values in order to save on memory.

Now suppose a program uses numeric data that never changes. The room move table in "Adventure" is a good example of this. My "Adventure" has 126 rooms and there are 10 possible directions to take out of each room (N=1, NE=2, E=3, ... NW=8, UP=9, DOWN=10). If an array were used to hold this data, it would contain 126 times 10 or 1260 elements. At 6 bytes for each element, this table would occupy 7560 bytes or almost one-fourth of my 32K memory. The data in this array would be room numbers to move into from each room. So for example, to move West (direction 7) from room 29, the contents of array element (29,7) would be the room number to move into going in that direction. Zero of course would mean no path that way.

This data never changes. Therefore it can be put into DATA statements, one DATA statement per room, 10 numbers (corresponding to the 10 directions) per DATA statement. Suppose the DATA statement for room number 1 is on line 10001, room 2 on line 10002, etc. Also suppose variable DR contains the direction in which the adventurer wishes to go and RC the number of the room he is currently in. Here is how the program would locate the room number to move into:

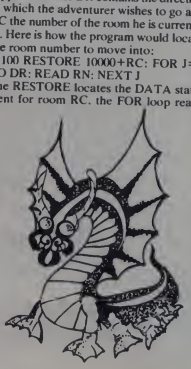
```
100 RESTORE 10000+RC: FOR J=1
TO DR: READ RN: NEXT J
```

The RESTORE locates the DATA statement for room RC, the FOR loop reads until the room number corresponding to direction DR is read at the end of the loop, RN contains the desired room number. Using this technique, I saved about 3650 bytes of memory on the room move table in my "Adventure" program.

To go even one step further, I put the data for rooms 1, 2 and 3 all on DATA statement 10003; rooms 4, 5 and 6 on DATA statement 10006 and so forth, thus eliminating two thirds of the DATA statements and saving another 600 bytes. The RESTORE statement will still work in Atari Basic because a RESTORE to line 10001 (for room 1) will actually start reading at line 10003 if lines 10001 and 10002 do not exist. Of course, the FOR loop had to be modifed to read the correct set of 10 room numbers as now there were 30 room numbers per DATA line. With this modification, the room move table has now been reduced from 7560 to about 3300 bytes for a 56% reduction in memory used.

Furthermore, upon examining the room move table data, I found that it contained many zeros. This occurs because there are exits from most rooms in only a few of the 10 directions. Therefore, I replaced n consecutive zeros in the DATA statements with the number -n. For example, if one of the DATA statements contained 8 zeros in a row, these zeros were eliminated and a single -8 put in their place. This was done in all DATA statements where 2 or more zeros occurred together. The read routine was then modified to expand negative numbers back to the original number of zeros as the data was read. This modification further reduced the room table from 3300 bytes to 2236 bytes now occupying 70% less space than if a 126 by 10 numeric array had been used. Thus, over 5300 bytes of memory were saved with several very simple modifications to the room move table part of the program.

Since numeric data items require 6 bytes each when stored in numeric variables or arrays, if the data does not change during program execution, keep it stored in DATA statements and READ it when it is needed. Pack it on the DATA statements as tight as you can. Otherwise use string arrays if possible. The fewer numeric arrays a program uses, the more memory will be available to it.



Strings

Although strings require less memory than numeric arrays, still try to keep their length to a minimum. Don't set up A$(100) when the maximum length A$ will ever be is 50 characters. Also, eliminate string variables when possible. If three strings are defined in a program and one of the strings could do the functions of all three, eliminate two of them.

"Adventure" type programs always have a vocabulary of words which they recognize (NORTH, TAKE, DRAGON, INVENTORY, DIAMONDS, etc.). Cut these words down to their first five characters (NORTH, TAKE, DRAGO, INVEN, DIAMO, etc.) Although some games use the first four or three characters, five is about the minimum length which can be used and still make the words unique. When the player's input is received, each word of it is truncated to five characters before a search is done against the vocabulary in the program.

As discussed previously with numeric data, place the vocabulary in DATA statements and READ it when it is required. In Atari Basic, strings are placed in DATA statements without quotes and are separated by commas. Since Atari Basic does not have string arrays (e.g. A$(100) does not mean 100 strings, but defines a string to be a maximum of 100 characters long), to store the words otherwise, they would need to be packed into a string. Since the words are variable in length (INVEN is five characters long but TAKE is four, OIL, three, etc.), this would require extra program statements and overhead. With the vocabulary on DATA statements, it may be searched by READing it from beginning to end with a special character (*, $, etc.) marking the end of the table.

This will take a considerable amount of time, especially for words at the end of the table. Therefore, a more efficient way is to place all words beginning with the same letter in a separate DATA statement. Then a RESTORE is used, keyed off the first character of the word being searched for, to locate the DATA statement containing all words starting with this letter.

As can be seen, putting both numeric and string data into DATA statements can be a very effective way to reduce the amount of memory required by a program. Before numeric arrays and strings are set up, consider the use of the READ/DATA statement technique. It may make the difference in being able to get a program into memory.

Eliminate Unneeded Statements

When you need to alternate a program variable between 0 and 1, how do you do

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it? Before reading on, take a piece of paper and write the Basic statements to set B equal to 0 if its value is 1 and vice versa (keeping in mind that Atari Basic does not have an ELSE capability). Now look at your programming. Is this the way you did it?

```
10 IF B=0 THEN B=1: GOTO 30
20 B=0
```

Or how about this way?

```
10 ON B+1 GOTO 20: B=0: GOTO 30
20 B=1
```

Or better yet?

```
10 ON B+1 GOTO 20: B=-1
20 B=B+1
```

Each of these methods is good and will accomplish the task, but they all use two lines. Is there a way (without using ELSE) to write this code on one line? Yes there is. A little creative programming reveals the following method:

```
10 B=ABS(B-1)
```

The first three examples require 52, 60 and 53 bytes respectively; the last example only 20 bytes. The point here is, eliminate unneeded statements wherever possible to save on memory.

I found in my "Adventure" program that the statement:

```
Z=B: GOTO 90
```

occurred 16 times. So I did the obvious; kept the first occurrence of this statement and replaced the other 15 with a branch to the first one. Now I know I have just caused a program abort to occur in the mind of every structured programmer in the audience. Please note, I am not against structured programming.

In fact, I encourage it along with good program documentation wherever possible. However, the preceding example saved 90 bytes of memory. By doing this same thing with several other statements that occurred multiple times in the program, I was able to save another several hundred bytes. So use of this technique really paid off.

Untokenize The Program

When Atari Basic places a statement into memory, it uses a "tokenized" form. That is, each Basic keyword, each arithmetic operator and each relational operator are replaced by a unique 1-byte code called a token. At the same time (as previously discussed), constants are placed in memory in internal form and variable names are placed in the VNT (Variable Name Table). This is the way Basic interpreters work. Thus, they automatically provide some efficiency in their use of memory.

Now, after a new program is entered into memory, typically a debugging phase begins. The program is run and rerun (and rerun and rerun and rerun....) many times to find and correct as many logic errors as possible. In this phase, statements are added, changed, deleted, rewritten, etc. If the program is large, debugging may take many days or weeks. During this time a number of variable names which were once used in the program will probably be completely eliminated. Or a typing error may have caused the variable TB, for example, to be entered when T was supposed to be used. Later on, this error is discovered and TB is replaced by T in the statement, thus completely eliminating the variable TB from the program.

Sounds logical so far, doesn't it. However, something else occurs that is not immediately obvious. When TB is replaced by T, Basic, being an interpreter, does not know that the variable TB has been completely eliminated from the program. Basic has no way of knowing that TB is now used in any other statement. Therefore, TB still occupies 4 bytes in the VNT and 6 additional bytes of memory are still reserved to hold the value of TB. Ten bytes of memory are being used by TB. Multiply this by another 10 or 15 variables that may have been used in the program but have since been eliminated, and we find a hundred or more bytes of memory being wasted.

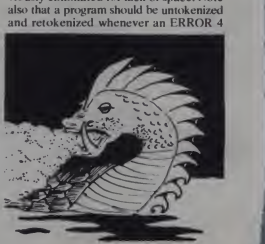
"Well," you respond, "when I CSAVE the program onto tape and then CLOAD it back into memory, doesn't the VNT and related memory get cleaned up?"

The answer to this question is "No," because a CSAVE causes the tokenized version of the program to be written onto tape and along with the tokenized program, the VNT and associated memory are also written. One of the reasons CSAVE works this way is because the tokenized version takes much less time and tape to write out. Now when a CLOAD is done, the old VNT still containing the unused variable names and their associated memory is read back in unchanged.

How do you eliminate the unused variables from the VNT and free up their memory bytes? Simple. The program must be written out in its untokenized form. This is the form that is seen on the screen when the program is listed with the LIST command. In Atari Basic, this is done exactly like a CSAVE except the command LIST"C" is used. LIST"C" causes the program to be LISTed to cassette tape. The tape will be written with the untokenized version of the program only and not include the VNT nor any other values from memory.

Note, this process will take two to three times as long as CSAVE and require at least twice as much tape. The tape should then be rewound, NEW typed to clear memory (this is important to erase the old program and VNT), and the untokenized version read back in with the command ENTER"C" (which works just like CLOAD). The untokenized statements will be read in one by one, retokenized and a new VNT constructed. Since the old variable names are no longer in this set of Basic statements on tape, they will not be entered into the new VNT.

When I had finished debugging my "Adventure" program, I untokenized and retokenized it and gained 150 bytes of memory. This allowed me to add a few more vocabulary words that I had previously eliminated for lack of space. Note also that a program should be untokenized and retokenized whenever an ERROR 4



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occurs. Error number 4 means the VNT is completely full with 128 variable names. Of course, if the program actually has 128 legitimate different variable names, then this method will not work and some of the variable names must be eliminated or combined into an array (which takes up only one slot in the VNT).

Use of POP Statements

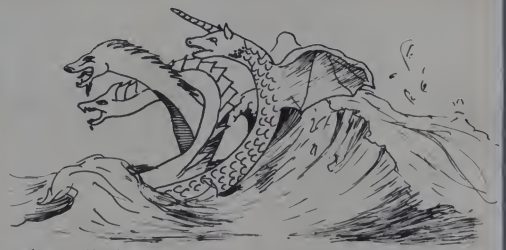
When I finally had the "Adventure" program finished, there were 450 bytes of memory available after loading and 50 bytes free after execution began. I felt the program was now bug-free and ready for the final test: my 10-year old son, David. But a strange thing began to happen. After David played for one or two hours, ERROR 2 would occur and the program would abort. Error number 2 means out of memory. This error would occur randomly after about an hour of play without restarting the game, and always at a different spot. How could this be? I had very carefully calculated that there should be at least 50 spare bytes of memory. I was puzzled. It took me a while to figure out what the problem was, but I finally found it.

When a GOSUB is executed, Atari Basic puts the return address into a push-down, pop-up stack in memory. Then when the RETURN statement is executed, the top address is popped off of the stack and the computer returns control to the program at this address. Thus the stack is constantly expanding and contracting in memory as GOSUB's and RETURN's are executed. Now suppose a subroutine branches elsewhere in the program, never executing a RETURN statement. The return address remains on the stack forever. This is exactly what was happening in my program. Every once in a while the program would exit from a subroutine without executing a RETURN. Each time this happened, 4 bytes of memory remained on the stack, never to be released, and the stack gradually expanded until it had eaten up the 50 bytes of available memory.

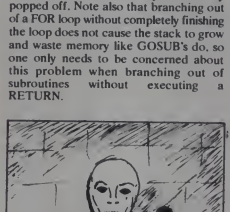
There are two ways to eliminate this problem. The most obvious is to exit from every subroutine via a RETURN statement. However, it is not always possible nor desirable to do this. Therefore, before branching out of a subroutine where the RETURN will never be executed, a POP statement should be inserted. This causes the stack to be popped up one time, and the return address removed, just as if the RETURN statement had been executed. The format of this statement is:

100 POP

In my program, I put several POP statements just before the INPUT statement. The program continually returns here to get the player's next response. Thus, I made sure at this point that the stack was completely empty. Executing a POP when the stack is empty acts like a do-nothing statement and does not cause an abort. This small modification solved the problem.



One note of caution when using POP statements in Atari Basic: FOR loops are also placed on the stack. Therefore, if a program is in the middle of a FOR loop when a POP is executed, the FOR information may be removed from the stack. This will cause the program to abort with error number 13 (NEXT encountered with no matching FOR) when the corresponding NEXT statement is executed. The way to avoid this is to make sure POP statements are not placed within FOR loops, or to make sure that you know exactly what order FOR and GOSUB information was placed on the stack so it may be correctly popped off. Note also that branching out of a FOR loop without completely finishing the loop does not cause the stack to grow and waste memory like GOSUB's do, so one only needs to be concerned about this problem when branching out of subroutines without executing a RETURN.



Message Text

Approximately one half of the memory in my "Adventure" program is text consisting of room descriptions and messages. Since the original "Adventure" text is too large to fit, it had to be cut down. There are several way to do this.

One way is to eliminate completely a number of the least used, least important messages. Another way is to delete some of the descriptive adjectives and/or change the wording so that the message is smaller but still retains its original meaning. Abbreviating, using contractions and substituting smaller words all help considerably. Here is an example:

Original message: "You are in a complex junction. A low hands and knees passage from the north joins a higher crawl from the east to make a walking passage going west. There is also a large room above. The air is damp here."

Abbreviated message: "You're in a complex junction. A low N pass joins a higher crawl from the E making a walking passage W. There's a large room above. The air is damp." Counting spaces, the message has been reduced by 28% from 204 to 147 characters.

Half of the room descriptions (63) begin with the 11 characters 'You are in" (including the space following the word in). I eliminated these words from the front of those 63 messages and modified the print message subroutine to print them if the first character of the message to be printed was not a capital letter. This resulted in another 600-byte savings.

Message text is stored in DATA statements. Message number 1 at line 15010, message 2 at line 15020, etc. The start of a message is located with a RESTORE 15000+N*10 where N is the message number. Many of the messages extend onto multiple DATA statements.

A special character which is not used anywhere else in the message text was placed at the end of every message. This character is detected by the print message subroutine telling it when the end of the message has been reached. Adding this single character per message was the simplest way to allow the program to determine the end of a message when the messages were variable in length. This method also uses the least amount of memory.

With a little creative rewriting, the

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16	SALVAGE	Determines salvage value of an investment
17	RRVARIN	Rate of return on investment with variable inflows
18	RRCONST	Rate of return on investment with constant inflows
19	EFFECT	Effective interest rate of a loan
20	FVAL	Future value of an investment (compound interest)
21	PVAL	Present value of a future amount
22	LOANPAY	Amount of payment on a loan
23	REGWITH	Equal withdrawals from investment to leave 0 over
24	SIMPDISK	Simple discount analysis
25	DATEVAL	Equivalent & nonequivalent dated values for oblig.
26	ANNUDEF	Present value of deferred annuities
27	MARKUP	% Markup analysis for items
28	SINKFUND	Sinking fund amortization program
29	BONDVAL	Value of a bond
30	DEPLETE	Depletion analysis
31	BLACKSH	Black Scholes options analysis
32	STOCVAL1	Expected return on stock via discounts dividends
33	WARVAL	Value of a warrant
34	BONDVAL2	Value of a bond
35	EPSEST	Estimate of future earnings per share for company
36	BETAALPH	Computes alpha and beta variables for stock
37	SHARPE1	Portfolio selection model-i.e. what stocks to hold
38	OPTWRITE	Option writing computations
39	RTVAL	Value of a right
40	EXPVAL	Expected value analysis
41	BAYES	Bayesian decisions
42	VALPRINF	Value of perfect information
43	VALADINF	Value of additional information
44	UTILITY	Derives utility function
45	SIMPLEX	Linear programming solution by simplex method
46	TRANS	Transportation method for linear programming
47	EOQ	Economic order quantity inventory model
48	QUEUE1	Single server queueing (waiting line) model
49	CVP	Cost-volume-profit analysis
50	CONDPROF	Conditional profit tables
51	OPTLOSS	Opportunity loss tables
52	FQUOQ	Fixed quantity economic order quantity model

NAME	DESCRIPTION
53 FQEOWSH	As above but with shortages permitted
54 FQEOQPB	As above but with quantity price breaks
55 QUEUECB	Cost-benefit waiting line analysis
56 NCFANAL	Net cash-flow analysis for simple investment
57 PROFIND	Profitability index of a project
58 CAP1	Cap. Asset Pr. Model analysis of project
59 WACC	Weighted average cost of capital
60 COMPBAL	True rate on loan with compensating bal. required
61 DISCBAL	True rate on discounted loan
62 MERGANAL	Merger analysis computations
63 FINRAT	Financial ratios for a firm
64 NPV	Net present value of project
65 PRINDLAS	Laspeyres price index
66 PRINDPA	Paasche price index
67 SEASIND	Constructs seasonal quantity indices for company
68 TIMETR	Time series analysis linear trend
69 TIMEMOV	Time series analysis moving average trend
70 FUPRINF	Future price estimation with inflation
71 MAILPAC	Mailing list system
72 LETWRT	Letter writing system-links with MAILPAC
73 SORT3	Sorts list of names
74 LABEL1	Shipping label maker
75 LABEL2	Name label maker
76 BUSBUD	DOME business bookkeeping system
77 TIMECLCK	Computes weeks total hours from timeclock info.
78 ACCTPAY	In memory accounts payable system-storage permitted
79 INVOICE	Generate invoice on screen and print on printer
80 INVENT2	In memory inventory control system
81 TELDIR	Computerized telephone directory
82 TIMUSAN	Time use analysis
83 ASSIGN	Use of assignment algorithm for optimal job assign.
84 ACCTREC	In memory accounts receivable system-storage ok
85 TERMSPAY	Compares 3 methods of repayment of loans
86 PAYNET	Computes gross pay required for given net
87 SELLPR	Computes selling price for given after tax amount
88 ARBCOMP	Arbitrage computations
89 DEPRSF	Sinking fund depreciation
90 UPSZONE	Finds UPS zones from zip code
91 ENVELOPE	Types envelope including return address
92 AUTOEXP	Automobile expense analysis
93 INSFILE	Insurance policy file
94 PAYROLL2	In memory payroll system
95 DILANAL	Dilution analysis
96 LOANAFFD	Loan amount a borrower can afford
97 RENTPRCH	Purchase price for rental property
98 SALELEAS	Sale-leaseback analysis
99 RRCONVBD	Investor's rate of return on convertable bond
100 PORTVAL9	Stock market portfolio storage-valuation program

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original "Adventure" message text was cut approximately in half so that it fit into 14K to 15K of memory, but still retained its original meaning. The attractiveness of the game was not lost, and all of the excitement of the original "Adventure" was still there even though the messages were now in an abbreviated form.

Miscellaneous

Here are a few other hints for optimal memory use:

1. Do not use long variable names (Atari Basic allows up to 120 character names, all characters significant). Each character in a variable name occupies 1 byte of memory in the variable name table.

2. Replace IF X <> 0 with IF X (which is equivalent and saves 3 to 9 bytes depending on whether the 0 is a constant or a variable).

3. Use GOSUB's to eliminate multiple occurrences of identical program statements.

4. Use as few variable names as possible by making them do double and triple duty. Rahter than use I, J, K, L, M and N as FOR loop variables, or Z0 through Z9, see if you can get along with using just I and J or Z1 and Z2. The same applies to scratch variables and other variables in the program.

5. Remove unnecessary parentheses and rely on operator precedence wherever possible (except, due to a known bug in Atari Basic, always enclose NOT and its associated variable in parentheses—(NOT B) instead of NOT B).

6. Spaces may be used anywhere for program readability (except of course in strings). Spaces are not stored in memory when a program statement is tokenized.

7. A new line always requires 6 bytes of overhead regardless of the size of the line number used.

8. Change IF NOT (A=B and C=D and E=F...)
to IF A <> B OR C <> D OR E <> F...
Change IF NOT (A=B or C=D or E=F...)
to IF A<> B AND C <> D AND E <> F...
Memory will be saved in both cases.

9. Use of the LET keyword does not cause extra memory to be allocated. It may be included or omitted as desired.

10. The RUN command clears all simple numeric variables to zero and sets all strings to empty (length zero) so don't waste memory clearing them. However, numeric arrays are not cleared! If they must be initialized to zero, use a FOR loop (all on one line, of course).

11. Many of the Atari Basic keywords can be abbreviated. Abbreviations have no effect on memory utilization.

Memory Saving-Techniques

Here is a summary of the memory-saving techniques discussed in the accompanying article:

1. Eliminate REMarks.

2. Pack multiple statements per line to eliminate numbers.

3. Replace constants and line numbers with variables.

4. Reduce the dimensions of and/or eliminate numeric arrays (convert to strings or use DATA statements).

5. Keep strings small and put them on DATA statements.

6. Eliminate all unnecessary statements, especially multiple copies of the same statement.

7. Untokenize and retokenize.

8. Keep the FOR/GOSUB stack from eating up memory.

9. Reduce the size of message text.

10. Use short variable names.

11. Replace IF X <> 0 with IF X.

12. Use subroutines to eliminate duplicate statements.

14. Eliminate unnecessary parentheses.

15. Rewrite to eliminate NOT.

16. Don't initialize to zero exception—numeric arrays).

Summary

Do these techniques really work? From experience I can emphatically say, "Yes they do!" Before applying these methods, I estimate the executable part of my "Adventure" program would have required 26K bytes of memory. After optimization, it uses only 15K bytes, a 42% reduction. Likewise, the message text was reduced from roughly 24K to 15K. Thus I was able to get a 50K program running in 30K of memory for a 40% reduction in memory usage. With most unoptimized programs today, a 25% to 40% gain in memory can probably be realized with a little effort in applying some of these RAM cramming techniques. Thus, the savings can be substantial!

One last question lingers which must be answered: After optimization for efficient memory use with these methods, how slowly does the program actually run? When I had finished the "Adventure" program, I did find the response to the player's input to be too slow. It was in the five to ten second range. However, upon investigation I discovered that the program was taking five seconds searching the vocabulary list. The further down the list it had to search, the longer it took. Therefore, I did sacrifice some memory by placing words that start with the same letter together on separate DATA statements. Then I changed the search routine to do a RESTORE to the proper DATA statement keying off of the first letter of the word that was being searched for. This reduced the search from a maximum of 150 words to 20 or less. Also, I placed the most often used words at the beginning of each DATA statement. Thus the vocabulary is not packed as tightly onto DATA statements as it could be. However, with this one small change, response time is now in the one to two second range for most responses, with a maximum of five seconds for the GET/TAKE verb which has the largest number of program statements associated with it. It appears that, on the Atari 800, chaining constants to variables, reading from DATA statements, jumping all over the place with GOTO's and GOSUB's etc. doesn't cost the program too much in time. This, of course, may not be the case for a program that uses some of the fancy Atari sound and graphics capabilities. However, for "Adventure" in graphics mode 0 (full screen text), the speed is adequate, even when a Basic program is highly optimized for memory usage.

I encourage you to experiment with your computer. Try the things I have suggested. Discover some new techniques and then tell us about them. We are interested. As for me, now that I know what a powerful system I really have, I am going to spend this summer actually swimming in the pool! □

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The New Man On-Line

Bill Johnson, President of the Heath Company.

Betsy Staples

In most industries contemporary parlance uses a nautical reference in speaking of new officers coming "on board." We don't think it has become an industry standard yet, but at least one computer company seems to have adopted a phrase more appropriate to its business: we were told recently that the new president of the Heath Company came "on line" in January 1981.

We don't know what he was doing in his off line days, but we assume it was something significant, because Bill Johnson is familiar with the microcomputer industry, knows the position of his company in it, and has some very realistic plans for the future.

In an interview at Creative Computing, Johnson cited a rapid increase in computer sales at Heath. The Heath Company, now a division of Zenith Data Systems, "hit a milestone in 1980 when it crossed the $100 million mark in sales," says Johnson. "Forty million of that was in computers."

The Kit Business

Despite projections indicating that the hobbyist market has reached saturation, Johnson sees no slowdown in the sales of Heathkit computers. "I read all those things and love it—because people say 'don't get into that business,' " he says.

"I would say that there is greater growth coming in the personal and business markets, because there are simply more of those people who have problems to be solved. But the hobbyists were the first people in, and I can assure you that our business is growing very healthily. Our computer business is growing at a rate in excess of 50% per year, and the kit side is participating fully in that growth. We are totally committed to serving the kit segment of the market."

Heath's main claim to fame in the kit market, Johnson feels, is "our competence in writing construction manuals. We also have 57 locations around the country to hold the customer's hand and provide parts, etc."

The Heath motto, 'We will not let you fail,' Johnson thinks, "feels warm and fuzzy to a lot of people."

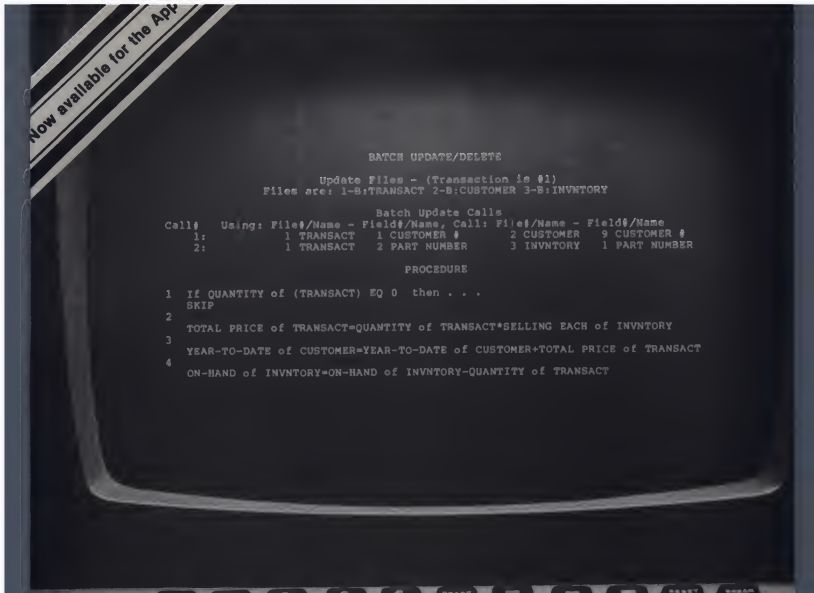
Assembled Side

Before Heath was acquired by Zenith, company plans called for distribution of assembled Heath computers through retail computer stores and other outlets. After the acquisition, management quickly agreed to rename the division Zenith Data Sytems. "It partitioned the kit business away from the retail or assembled line better. I know if I were a small business man, I would feel better with a Zenith Data System sitting on my desk than a wired kit," Johnson explains.

He adds, "I think we are perceived in the kit business as having good quality, design, etc., but I don't think that transfers particularly well to the assembled side."

Is Zenith Data Systems an arms-length operation, or is it the same operation with a different nameplate? It's both. The new Computer Business Group, which designs products, seems to be the bridge between the two divisions.

As Johnson explains it, once a product is designed, it can fall into either the kit or the assembled computer division, or both. The Computer Business Group also handles software for both divisions. Where, a year or two ago, Heath employed 16 or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1: 1 TRANSACT 1 CUSTOMER # 2 CUSTOMER 9 CUSTOMER #
2: 1 TRANSACT 2 PART NUMBER 3 INVNTORY 1 PART NUMBER
PROCEDURE
1 If QUANTITY of (TRANSACT) EQ 0 then . . .
SKIP
2
TOTAL PRICE of TRANSACT=QUANTITY of TRANSACT*SELLING EACH of INVNTORY
3
YEAR-TO-DATE of CUSTOMER=YEAR-TO-DATE of CUSTOMER+TOTAL PRICE of TRANSACT
4
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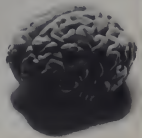

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CIRCLE 167 ON READER SERVICE CARD

17 hardware engineers and "a couple of software people." there are now 45 to 50 hardware people and 37 or 38 software people "with open requisitions for at least another 15 if we can find them."

Software

There are obviously many fewer second sources (independent producers) of software for Heath/Zenith machines compared to those who write for other popular computers. To what does Bill Johnson attribute this?

One of the reasons, he thinks, is "the perceived lower base of products in the field." However, he cites two recent surveys which list Heath/Zenith as number three in the U.S.

"Another thing is that in the beginning we marched off to our own drummer with HDOS—our own operating system—and with our own bus and some other things that, if we had to do over again, we probably wouldn't do that way."

Heath currently has three levels of software support. Languages and operating systems carry the Heath label and are documented in the "full Heath style." Heath also supports HUG, the Heath Users' Group, to the extent that the company provides a means by which programmers can exchange original and public domain software.

Between these two levels is quality applications software bearing the SoftStuff label. Most of the programs in the SoftStuff line are polished, documented versions of programs submitted by users who receive royalties from Heath.

In addition, Zenith Data Systems has recently announced the availability of four software packages for the Z-89. WordStar, MailMerge, DataStar and SuperSort, all of which run under CP/M, are being offered under a license agreement with Micro Pro International.

Heath will continue to offer high technology items in kit form.

What's Ahead for Heath

"I think that the position that Heath has in the marketplace fits in with the image Zenith has of itself and its future," Johnson says. "We know that we are in the television business, and that's wonderful, but there isn't a lot of profit in it. The T.V. market is not growing very much; it is primarily a replacement market."

One area into which Johnson thinks Heath can expand, capitalizing on its expertise in electronic education, is teaching service technicians to repair and maintain high technology equipment: "A lot of service organizations have been servicing mechanical gasoline pumps, for example, for years. Now they have to learn how to service digital ones. We're in a position to teach them how—we know how to teach people to do things step-by-step."

He believes Heath will continue to offer high technology items in kit form. Research the company has done reveals that the desire to have something innovative and the desire to have a hand in creating it are very influential in Heath customers' decisions to buy.

In addition, Johnson promises that Heath will not abandon quality. "This decision has forced us into a position of occasionally having a product that costs as much or more than the mass-produced, assembled version," he says.

"It boils down to this: if a product requires a great deal of labor and there is a relatively small market for it and the industry is not making 10,000 a day, we can save the customer a lot of money. But when the industry tools up and starts making products at the rate of 10,000 or 100,000 a day, they take all the labor out—their economies or scale are so much greater than ours that by the time we write the manual and pack up all the parts, our labor can cost us as much as running a Zenith T.V. set down the assembly line.

"In consumer products, when the industry is tooled up, we get out. We got out of the calculator business, and we did the same when we had the first CB unit—we can't be competitive when the market gets flooded.

"Our thing is technology. We didn't invent the microprocessor, but when chips are expensive, before they slide down the price curve, we sell direct. We don't have any of the labor—the customer supplies that. We can get it into a consumer application quickly. We have digital marine gear, digital television sets, digital audio gear, and probably as many microprocessor-based consumer products today as anybody.

"But as the industry tools up to make them by the bunches, we will go on to something else. Proof of this is the fact that 47% of the products that were in our catalog in 1978 are gone, and half the dollar volume that we expect from the current catalog will be from products that are less than three years old. We have to keep coming up with new ideas, new things." □

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Strategies for Successful Simulation

Bruno B. Wolff, Jr.

Simulation means making something act like the real world. There we have cause and effect, strong and weak influences, thresholds and limits, chance events, cooperation and competitive situations—all factors in an outcome or result.

In writing computer programs there are several programming techniques that are useful in simulating a certain event. Although I will describe these techniques using Apple Integer Basic and Applesoft, these techniques are easily transferable to other forms of Basic and to other languages as well.

This article will deal with cause and effects, giving some hints on how to get outputs that relate to certain inputs. We will present some ideas on additive and subtractive influences; weighted influences; thresholds and limits; straight line (linear), curved (curvilinear), logarithmic, and trigonometric relations.

Then we will discuss chance events, going into uniform, normal, skewed, and absolute distributions. Don't leave yet; it isn't as complicatd as it sounds.

Then we'll go into some ideas on cooperative and competitive techniques.

The philosopher David Hume believed there was no such thing as cause and effect—that there was just a succession of events to which we ascribed a cause and effect relationship if the one followed the other often enough.

We'll assume, though, that one thing can cause another. Let's try a simple idea.

We have a bushel of seed corn containing 12,000 seeds. Each seed can produce 15 ears of corn. If we plant all the seed (our cause) we'll get a certain effect—lots of ears of corn.

EARS = SEEDS * 15

Bruno B. Wolff, Jr., 2004 E. Kensington, Shorewood, WI 53211.

This is a very simple simulation. But we know we need rain, a proper growing season, fertile seeds, the right fertilizer, pesticides, and proper acreage to grow crops. What is the cause of the corn that grows? Actually all of these factors influence the growth of the corn. Some influence the growth more than others, and some act only within certain limits, or even act adversely outside certain parameters.

So we can have too little or too much rain, not enough or too much fertilizer, or we can apply pesticides up to a certain amount beyond which they no longer have an effect.

Let's take these different situations one at a time. First, let's see how we can weigh the influence of one event upon another. It may seem obvious, but some influences are positive and others negative. So, for instance, if the insect population grows, it has a negative effect on our corn production.

We can present a series of general formulae. "Y" will represent the effect and "X" the cause.

No.	Formula	Net Effect
1	Y = A + B *(X+C)	positive
2	Y = A - B *(X+C)	negative
3	Y = A + B /(X+C)	negative
4	Y = A - B /(X+C)	positive

In these formulae A, B, and C are constants, each of which affects the influence of the cause. Did you notice that 1 and 2 are really the same if we can let constant B have a negative value? The same holds true for 3 and 4 although here the minus sign in front of B is really positive in the influence of X on Y. By a positive influence I mean that as cause X gets larger, effect Y gets larger.

Listing 1.

```
 50  TEXT
100  INPUT "ENTER THE NUMBER OF VALUES OF X YOU WANT TO RUN ";K
110  DIM Y(K)
120  FOR J=1 to K:Y(J)=0:NEXT J
130  INPUT "ENTER THE MAXIMUM VERTICAL VALUE":HV
140  INPUT "ENTER THE MINIMUM VERTICAL VALUE":LV
150  IH=279/K
160  CV=191/ABS(HV-LV)
170  REM INSERT BETWEEN LINES 200-499 YOUR EQUATION USE X FOR THE
     INDEPENDENT VARIABLE (THE CAUSE) AND Y FOR THE DEPENDENT VARIABLE
     (THE EFFECT)
180  REM CONSIDER X ANY Y AS ARRAYS DIMESNIONED TO THE MAXIMUM NUMBER OF
     TRIALS
190  HGR2
195  COLOR=2
500  FOR J = 1 TO K
510  XP=IH*(J-1)
520  YP=191-CV*(Y(J)-LV)
530  FOR L = 191 TO YP STEP - 1
540  HPLOT XP,L TO XP+IH,L
550  NEXT L
560  NEXT J
570  END
```

Run this little test program to see how this works:

```
100 FOR X = 1 TO 10
110 FOR B = -5 TO 5
120 Y = 100 + B* (X+1)
130 PRINT Y;";
140 NEXT B
150 PRINT
160 NEXT X
170 END
```

You can see how the constant B affects the relationship.

In order to make this presentation more meaningful, you may want to graph out the various formulae. Listing 1 is an easy to input and use generalized graph program. You can use this, as you read this article, to illustrate the effect of various changes in variables or to graph out changes later, as you use some of the techniques in writing your own simulations.

Notice that the test program, if you use the graph, plots in a straight line. This kind of relationship is called linear, i.e., for each unit increase of X, there is a constant increase (decrease) in Y.

Let's give some names to "A," "B," and "C" that describe their influence on the result. "A" is a starting point. It can also be a minimum or maximum. If it is very large in relation to X, it can affect the magnitude of the effect of X on the formula. Let's call this the size factor. "B" is what tells how big a jump we make each time X changes. It affects the scale of X. We call this the scale factor.

"C" regulates how much the scale moves when X changes. If "C" is large, sensitivity is low. If it is small then Y becomes more sensitive to X. "C" is, then, the sensitivity factor.

All three factors work together, of course, but our names give you a feel for the principal influence of each.

Let's go back to our cornfield again,

Always be sure to set limits for values that in reality cannot go below or exceed a certain value.

and just consider the effect of fertilizer. Even if we put no fertilizer on, we'll grow corn. Let's also now combine our seeds parameter to see how two influences can affect the result.

Where F=bags of fertilizer, S=bushels of seeds, and H=harvest in bushels, let's print out the effect of changing both factors. If you want, use the generalized graph program to plot this.

```
100 FOR S = 10 TO 15
120 FOR F = 5 TO 10
130 H = S * (10+F/10)
140 PRINT H
150 NEXT F
160 NEXT S
170 END
```

Now let's take a look at thresholds and limits. In our case we can say that rain falls within certain limits. It can never be less than zero and its upper limit is restricted by some historical maximum.

```
100 IF R<1, THEN R = 0
105 IF R >20 THEN R = 20
110 H = 15 - 15/(R+1)
```

As R (for Rain in inches) increases, so does H (the harvest). If R=0, what is the value of H? We could say that the threshold value of R is 1. What if we change the formula slightly.

```
110 H = 15 - 30/(R+1)
```

Now R must be greater than 1 for H to be positive. You'll notice I sneaked in lines 100 and 105 above. This is one way to set a limit so you don't go below zero where that's an impossibility. I'd caution you to keep this little warning in mind: always be sure to set limits for values that in reality cannot go below or exceed a

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certain value. In the second formula what lower limit should be set for R?

Try this in your machine.

```
100 FOR R = 1 TO 15
110 H=15 - 30/(R+1
120 PRINT H
130 NEXT R
140 END
```

Here's another way to set a limit using a combination formula. We assume that adding pesticides is a way to increase the growth of our corn. But again, as in the rain, we need a minimum amount, but we also recognize that as we add pesticide we begin to flatten out its effect, and more and more of the pesticide goes to waste.

$$H = 15 + \frac{P*10 - 8}{P + 1}$$

Write a Basic program to illustrate the effects of the pesticides, and see what happens.

This last example brings in another point, leading into our discussion of curvilinear equations.

If you tried to graph the last equation, your plots no longer traced a straight line. The amount of increase in Y with respect to an increase in X was no longer uniform.

Here are examples of some curves that plot in various forms of curves.

Y=	$\frac{B}{X}$	hyperbolic
Y=	log X	logarithmic
Y=	x^t	parabolic
Y=	n∧X	exponential
Y=	SQR(R∧2-X∧2)	circular
Y=	sin X	sine curve

The hyperbola is a good curve for an event which, most of the time, has little effect, but once in a while has a very large effect. In our example a plague of locusts or other insects could be set to occur as a function of time—the seven year locust—or on a random basis. We'll talk about random numbers a little later.

$$H = \frac{100}{(Y \text{ MOD } 7) + 1}$$

Y	H
1980	14
1981	100
1982	50
1983	33
1984	25
1985	20
1986	16

Logarithmic and exponential curves are useful for showing growth curves of self-reproducing populations.

Circles, sine curves or other recurring kinds of curves are good for adjusting to seasonal events. In our formula the growing season could be set to a sine curve.

```
100 FOR X = 0 TO 3.14 STEP .05
110 H = SIN X + H
130 NEXT X
```

If you want to watch this on your machine add the following lines as a delay:

```
115 FOR J = 1 TO 500
120 NEXT J
125 PRINT H
```

If we had the ability to measure all the causes of an event, we could compute or infer what would happen.

This accumulates the harvest over a period of time starting out slowly, reaching a faster growth at the height of the 30-day harvesting season, and tapering off at the end.

Let's now undertake a synthesis, a putting together, of several of the independent formulae and make them interact, augment, or decrement each other to produce a simulation.

Let's first review the several formulae already considered.

```
H=S*15
H=S*(10+F/10)
H=15-30/(R+1)
H=15+(P*10-8)/(P+1)
H=100/((Y MOD 7)+1)
H=SUM OF SINX FROM 0 TO 3.14
```

Now let's write an Applesoft program to bring this all together. See Listing 2.

Listing 2

```
 90   S=S/2000
100   FOR J=0 TO D STEP .01
110   H=(S*(15+F/10)-S*20/(R+1))/3
120   H=H+(P*H*.7-H/3)/(P+1)
130   TH=TH+H*SIN(J)
140   NEXT J
150   MO=INT((Y/7-INT(Y/7))*7+.05)
160   TH=TH-TH/(MO+1)/2
165   IF TH O THEN TH=0
166   TH=INT(TH)
167   HOME
170   PRINT "YOUR YIELD WAS ";
      TH;" BUSHELS"
```

Notice that we have changed some of the constants, scale factors, and sensitivity factors to weight various parts of the formula more heavily than others. We also had to create a MOD function in line 150 because Applesoft, unlike Integer, does not have this function as part of the interpreter.

Now let's put in a way for you to set the variables. See Listing 3.

Listing 3

```
 10   PRINT "ENTER LENGTH OF
      SEASON IN DAYS "
 20   INPUT " NUMBER FROM 1 TO 90 ";D
 22   IF D<1 OR D>90 THEN 20
 25   D=D*3.14/90
 30   INPUT "ENTER AMOUNT OF SEED,
      0 TO 50000 "; S
 32   IF S<0 OR S>50000 THEN 30
 40   INPUT "ENTER TONS OF FERTILIZER,
      FROM 0 TO 100 "; F
 42   IF F<0 OR F>100 THEN 40
 50   INPUT "RAINFALL IN INCHES,
      FROM 0 to 20 "; R
 52   IF R<0 OR R>20 THEN 50
 54   IF R>15 THEN R = 30-R
```

We should halt here to note that we are trapping all input size errors and that in line 54 we are adjusting the rainfall to allow for too much rain.

```
 60   INPUT "ENTER TONS OF PESTICIDE,
      FROM 0 TO 50 ";P
 62   IF P<0 OR P>50 THEN 60
 70   INPUT "ENTER THE YEAR ";Y
 72   IF Y<1 THEN 70
```

Now take a few minutes sometime to try out this program varying the several parameters and see what kind of farmer you are.

To make the program more interesting you might assign cost figures to the seeds, fertilizer, and pesticide and determine a strategy for spending a predetermined amount of funds. To do that, add the lines in Figure 1 to the program in Listing 3.

Figure 1

```
  5   PRINT "YOU HAVE $10,000 TO SPEND.
      SEED IS $.10 PER SEED; FERTILIZER
      $500 PER TON; AND PESTICIDE
      300 PER TON."
  6   D0=10000
 34   D1=D0-S*.1
 36   IF D1>=0 THEN 39
 37   GOSUB 200
 38   GO TO 30
 39   D0=D1
 44   D1=D0-F*500
 46   IF D1>=0 THEN 49
 47   GOSUB 200
 48   GO TO 40
 49   D0=D1
 64   D1=D0-P*300
 66   IF D1>=0 THEN 69
 67   GOSUB 200
 68   GO TO 60
 69   D0=D1
175   PRINT
180   PRINT "WITH GRAIN SELLING AT
      $12 A BUSHEL"
185   PRINT
190   PRINT "YOUR NET GAIN WAS"
195   PRINT" ";TH*12-10000+D0
196   PRINT:PRINT
197   GOTO 6
200   PRINT "YOU'RE OVERDRAWN BY $".
      ABS(D0-D1)
210   RETURN
```

Now before all you real farmers tell me I know about as much about farming as certain kinds of your livestock do, let me say this example is purely fictitious. To simulate the real world you must gather data, put them all together and try your formula with many examples, fine tuning by changing constants (size factor), scale, sensitivity, weights, types of curves and so on. This is the creative part of simulation.

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trying to understand what is going on in reality and converting that reality into a formula.

In life many events occur seemingly by chance. If we can believe Leibnitz, nothing would happen by chance; we could, if we had the ability to measure all the causes of an event, compute or infer what would happen. We could predict the future with certainty. But, of course, we can't even begin to get all the measurements we need to predict an event.

Look at weather forecasting or sports handicapping. The best we can do is compute the probability of an event—that is, that it has such-and-such a percent chance of occurring. We can get all the data we can to increase our knowledge about the causes of the event to improve the accuracy of our prediction. So in weather forecasting we read pressure, get reports from other stations, look at historical data, and so on. In sports, we review past performances, look at the injured lists, see what the teams' home and road records are. Some prognosticators read biorhythms or consult astrological tables.

In simulation we duplicate these techniques by assigning a percentage value to each outcome. The theory of probability had its origin in the computation of gambling situations. Cards, dice, roulette, and such games of "chance" all, in a sense, model life in that certain events occur randomly, but with a certain degree of probability which can be computed rather accurately. So we throw a die and we can say there's one chance in six that a "four" will turn up. Fortunately, in computing we don't have to throw dice, pick a card, or spin a wheel to simulate a random event. We have that wonder of wonders, the random number generator.

Typically these generate a number $>=0$ and <1.0. These numbers are uniformly distributed, i.e., there is an equal chance of generating .02 as .03; or $>=.02<.03$ as $>=.05<.06$. Just as we can generate different kinds of curves with equations we can make a random number operate in a nonuniform way by putting it into a formula that will generate a dependent random number that is distributed as we want it.

Here are a few examples in Applesoft formula notation.

Formula 1

```
100 Y=X^(RND(1)*10)
110 END
```

Formula 2

```
100 FOR J=1 TO 10
110 Y=Y+RND(1)*2
120 NEXT J
130 Y=Y/10
140 END
```

Formula 3

```
100 Y=RND(1)^2
110 END
```

You can use any of the other formulae, as well, to generate the kind of distribution you want—logarithmic, hyperbolic, parabolic, and so on.

One of the more useful formulae that we can use to represent reality is Formula 2 above. As you may know, certain events occur in what is called a normal distribution—the well-known bell-shaped curve; seemingly random events like people's height, annual rainfall, scores of tests, imperfections in manufactured products, an so on, occur in normal distributions. So, if you want to approximate these kinds of events, like the rainfall in our example, we can use a formula that will approximate a normal curve.

Seemingly random events like people's height, annual rainfall, scores of tests, imperfections in manufactured products, and so on, occur in normal distributions.

```
300 FOR N=1 TO K
310 R=R+INT(RND(1)*2)
320 NEXT N
330 E=INT(R*F)
```

This is a general formula you can use to generate a pseudo normally distributed number.

E is the value returned to your program. The average value is equal to K*F/2. So, in the example above if we want our rainfall on the average to be 10 inches, we could use K=20 and F=1 or K=40 and F=0.5, etc.

Sometimes we don't want to have a perfectly normal curve, but we want it to tail out more to one side than the other. These are called skewed distributions; a simple way to do this is to change the program slightly:

```
305 RT=INT((RND(1)*2)
307 MD=INT((J/3-INT(J/3))*3+.05)
310 IF RT=1 AND MD=1 THEN 305
315 R=R+RT
```

Then follow with lines 300-330 above.

Try both of these formulae 15 or 20 times and see how they plot. You can use the generalized graph program by adding the following lines:

```
200 TEXT
210 INPUT"INPUT CURVE
    SMOOTHNESS FACTOR";M
220 INPUT"INPUT MEAN
    CONSTANT";F
230 FOR L=1 TO M
240 R=0
340 Y(E)=Y(E)+1
350 NEXT L
360 HGR2
```

See what the curves look like varying M, K and F. The larger M, the smoother your curve. K is the largest value of Y and K*F/2 is the mean.

Listing 4 is another, more complex program that's an even better normal random number generator. Your main program, of course, would have line 100 set in some hard coded way and call the normal random routine as a subroutine; but we'll put it in as an independent program. Once again it would be fun to graph this for the returned value. In this program though, we work backwards. "X" becomes the dependent variable and "Y" is the independent variable which is the value returned to your program as the normalized random number. Let me explain the values "M" and "S." "M" is the average value you expect to get over a number of trials. "S" is what is known as the "standard deviation." Two thirds of the values put out by the program will be within + or - S of the mean. Ninety-five percent will be within 2*S and – 2*S of the mean, and 99 percent within 3*S.

Listing 4.

```
100  INPUT "MEAN AND SD ";M,SD
110  T=0
120  R=RND(1)
130  FOR Y=M-4*SD TO M+4*SD STEP .5
140  X=.399*(2.7183^(-.5*((Y-M)/SD)^2))
150  T=T+X
160  IF T/2/SD>R THEN 180
170  NEXT Y
180  PRINT "NORMALIZED RANDOM NUMBER= ";Y
190  END
```

You can use this to generate rainfall in your corn program; a mean of 10 with a standard deviation of 5 would work nicely.

The last random distribution I'll discuss I call the absolute. Absolute values can be generated in two ways—directly and by array. What do we mean by absolute? We mean there is no equation to link the cause and the effect. We get the effect by the cause pointing to a specified result.

Here's one using the direct method in Integer Basic.

```
100 Y=20
110 IF RND(10)>3 THEN Y=10
```

This method can also be used to branch which, while not as direct a cause-effect relationship, still leads to the program doing certain things in a random way. I use this in conjunction with other variables in a baseball game to determine to which field a ball is hit. If a batter is right-handed, the variable BLR is set to 15, 0 if left-handed. Remembering that left-field

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is 7, center 8, and right 9 and that lefties hit more often to right and vice versa, we use the following formula to show what field the ball goes to on a fly (using Integer Basic):

```
FIELD =(75-BLR+RND(25))/10
```

For a righthander the first part of the equation gives a value from 70 to 94 and for a lefty from 75 to 99. Therefore, a righthander will go to left on value of 70-79(10), center from 80-89(10) and right (90-94)(5), i.e., 40%, 40%, 20%. And the reverse for a left-hander.

The second absolute method is to fill an array with values and address a cell in the array by linking the random number to the position in the array. Here's an example in Integer Basic.

```
Y=X(RND(20)+1)
```

This will put the value of one of the 20 values in the X array into Y. In a football game I've used this to call up the average gain for a certain play. This is useful for situations calling for certain specific characteristics where the value of X is more a name or pointer than a causal force. You might use it to identify the characteristics of a randomly selected monster in an Adventure type of game.

Competitive Strategies

We've talked enough about random counts. Now we want to present a few ideas on competitive (or cooperative) two or more player situations where the choice of one player affects the results of another or where the combined effort of both either affects each other's results or a third effect.

As with the random number influence, we can divide our competitive strategies into two classes—direct and array. Here's an example of the direct using an example from the baseball game mentioned above. We need to set up a mechanism to account for the fact that left-handed batters hit better against right handed pitchers. and that switch hitters hit about equally well against either. From an array for pitchers we read PV(N) the variable being set to 15 if right-handed and 0 if left-handed. The value BV is also read from the batter's array and is set R=15, L=0, and switch-hitter 7. The larger the value of V. the better it is for the hitter.

```
V=ABS(BV-PV)*5-35
```

Another simple trick is to set a value and then change it if the two players match or don't match on a choice. For instance, following through on the baseball image, if the batter guesses correctly on a pitch he gains an advantage.

```
100 V=-50
110 IF PITCH = GUESS THEN V = 0
```

Now we have two parts of the competitive result which we can put into one formula:

```
V=ABS(BV-PV *5-85+50* (PITCH=
GUESS)
```

Another way to compare the actions of the two players is to compute a mean of the two inputs and affect the formula by comparing the differences in this mean.

I have a manufacturing game in which a final product price must be set independently by each of the "companies." So we have for three companies:

```
AVE=(P(1)+P(2)+P(3))/3
S (N)=1000*AVE/P(N)
```

This relates S(N), the market share of Company N to the average price.

When we set up a formula, obviously we have some value in mind as regards what the effect of the various causes should be.

We can insert a factor to make the equation more sensitive to price.

```
S(N) = 5000*(AVE/P(N)-0.8)
```

This formula eliminates any market for a company that charges 20% above the average price. You can vary the sensitivity to price by making the sensitivity constant (remember that label?) anything from 0.99 to any plus value. At plus values the market would begin to become very insensitive to price. If you change the sensitivity constant you must also adjust the scale constant to keep your expected result in balance.

Now say we want to introduce marketing expense as an option of the Company. We can assume that the more a company spends on marketing the larger the market it can engender, but it must also compete with the marketing of opposing companies.

```
T = M(1)+M(2)+M(3)
S(N)=M(1)/T*1000
```

Here we determine the market share by a straight percentage of the market as reflected by marketing expenditures. But we may want to recognize that marketing for such and such a product is more or less sensitive to marketing expense. So we can add a factor to account for this.

```
S(N) = (5000+M(1))/T*700
```

The quality of a product is also a factor and we can relate quality to quality control and research and development. Once again we could make this a straight reflection of the effect of these expenditures. Or we can immediately recognize a size factor to diminish this effect.

```
TQ=Q(1)+Q(2)+Q(3)
S(N)=1000*(3+Q(N)/TQ)
```

Finally, let's look at the array as a competitive or cooperative factor. We'll leave our management game for a while and go back to sports. The offensive team in football flashes in a play from the bench and the defensive captain also gets the word on how he should line up his team. This lends itself to picking two members that define a cell in a two-dimensional array. We use this in a football game to pick absolute numbers to adjust other parts of the formula to compute the result of a play. If the offense picks a running play up the middle and the defense has loaded for such a running play, we will send a minus factor to the formula. If the defense was looking for a run and we pass. then a plus factor is transmitted.

We can represent this in Applesoft Basic as:

```
R=C(O,D)
```

Where O=offensive play and D=defensive play.

Expected Results

Before we conclude this article. I want to spend a litle time on expected results. When we set up a formula, obviously we have some value in mind as regards what the effect of the various causes should be. We'll produce so many bushels of corn, or get a base hit so often. sell so many widgets, or gain so many yards.

For the simple formulae we have used in this article, we can easily compute the average or expected result of an equation. If we have an equation such as Y=X+C where values of X are between L (low) and H (high), we can compute the average results by the following formula:

```
AVE Y=((H^2)/2+C*H)-((L^2)/2+
C*L)/(H-L)
```

For a number produced by a random variable of 0 to 1, a similar formula will work.

```
Y=10*RND(X)+5
```

$$AVE\ Y = \frac{10*(1)+1*5=10}{2}$$

The low value, being 0, drops out of the equation. An easy way to do this is to put your random number to .05 and you'll get your average result in a linear equation.

Another way to get a mean value is the brute force method. Just run the program many times, accumulate the results and divide by the number of trials, and you'll have a very close approximation of the expected value.

For nonlinear equations. the formulae get a little more complicated. I recommend you use the brute force method then or dig out your calculus book and review definite integrals.

We've only touched the surface of a highly complex field. I hope you've gotten a few new ideas on a very practical level to help you in your attempts to convert reality into equations so that the world is right there inside your monitor. □

The National TRS-80 Computer Show

Private Audiences with Top Programmers

George Blank

For the tiny handful of the general public who attended, the TRS-80 computer show at the Statler Hotel in New York in late May offered plenty of opportunity to talk to the best known programmers for the Radio Shack computers. The show was dominated by software suppliers, and the exhibitors, many of whom were programmer-entrepreneurs, usually outnumbered attendees. Taking advantage of the free time and lack of attendance, many of the exhibitors renewed social contacts and made wry jokes about making enough money to cover their parking.

The show was cosponsored by **80 Microcomputing** published by Wayne Green who, despite his success in publishing magazines, has not been able to replicate it on the show circuit. Apparently he believes his magnetic personality will attract huge crowds, but it just hasn't worked. His previous show, in Boston two years ago, was also a disaster at the box office.

Actually, the show displayed a vitality in the TRS-80 marketplace, with several innovative software products. Scott Adams of Adventure International had several new products, including one of the most complex space games yet marketed. Starfighter, clearly an imitation of Atari's Star Raiders, comes with a 32-page instruction manual and it takes several hours just to figure out how the display and commands work. Another product introduced by AI was Commbat, a war game to be played by two persons on separate TRS-80 Model I computers connected over modems.

Bill Hogue of Big Five Software, supplier of some of the most popular TRS-80 arcade games, displayed new packaging and an innovative disk format that allows the same diskette to be loaded in either a Model I or Model III computer.

Many of the exhibitors renewed social contacts and made wry jokes about making enough money to cover their parking!

Roy Niederhoffer, teen-age president of Software Innovations, was there with Name That Tune, a computer imitation of a television quiz game, complete with commercials for his other software products.

Quality Software Distributors introduced the latest entry in the Scripsit program modification sweepstakes, Scriplus. The most innovative feature is an alphabetized diskette directory callable from within Scripsit. Another product handled by QSD is Omnitech's Move 3-2-1 and Move 1-2-3, a pair of programs that move some files back and forth between Model I and Model III computers. The programs come in a single package, but you need Percom's Doubler double density disk controller and Double DOS to down load programs from the Model III to the Model I, and the program cannot handle long files with extended directory entries.

Hardware products demonstrated at the show included two speech synthesis units. The Micro Mouth, by Micromint, sells for $199 and has a fixed 255 word vocabulary and remarkably clear and understandable speech. Type-'N'-Talk, by Vodex is far more ambitious. It contains a text processor that takes ordinary text and processes it into speech. The unit, selling for $349, contains a microprocessor and 4K of ROM memory, and works off any standard RS-232 port. While the speech is not as good as that of the Micro Mouth, the unit is flexible and about as easy to use as a printer. Any text is interpreted, but you might have to tamper with spelling to get it to sound right. Our name becomes CRE ATIV COM PEWTINGG and it is easy to recognize. Sensational Software will be offering several programs to support the Type-'N'-Talk on popular computers. □

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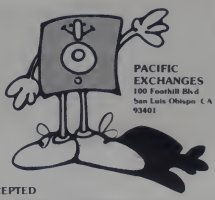

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How to Solve It—With the Computer

PART 8

Donald T. Piele

"Learning about computers without learning how to program is like learning about cars and not learning how to drive."

—A Student

It is common today to find people in all walks of life who have a deep disdain for computers. At all grade levels in education, there are those who are openly anti-computer and are proud of it. Some teachers firmly believe that computers in the classroom will diminish the ability of students to think for themselves and will lead to their ultimate dependence on a machine.

Fortunately there is evidence of a changing attitude among many educators towards computers in the classroom. A recent study funded by the National Science Foundation has shown that there is strong support among elementary and secondary teachers, parents, and administrators for the development of computer literacy for all students. The PRISM study (Priorities in School Mathematics) [1], carried out by the National Council of Teachers of Mathematics, has made important recommendations which relate to the use of computers in the classroom. These recommendations reflect the priorities of teachers, parents, and administrators at the local school level.

The objective of the PRISM study was to provide guidelines and suggestions for curriculum changes in mathematics for the 1980's. Two of the nine major areas under investigation were problem solving and computer literacy.

Problem Solving

The one area which all respondents agreed should be emphasized in the 1980's mathematics curriculum was problem solving. Over 95% identified the goal of problem solving as the development of methods of thinking and logical reasoning. Top priority was given to the development of new materials beginning at the elementary school level.

The problem with teaching problem solving is that it is not a traditional subject which can be mastered in complete detail. This understandably makes it difficult to teach problem solving using the methods that have proven successful for more traditional subjects, such as fractions. However, many texts try to do just this. The typical "story problem," so often used in text books ostensibly to develop problem solving skills, usually turns out to be an exercise in recalling a numerical fact or in fitting the problem into a memorized pattern—hardly a genuine problem solving experience.

Donald T. Piele, The University of Wisconsin-Parkside, Kenosha, WI 53141.

Computer Programming and Problem Solving

The bond between computers and problem solving is well established. Few people would deny the value of the computer for solving problems. In fact the history of computers parallels the history of man's search for ways to automate the problem solving process. But computers do not solve problems by themselves. They need instructions from humans. Computer programming—the creative art of transforming a set of humanly constructed procedures into machine executable code—is the crucial link between man and computer.

New Problem Solving Strategies

Computers are really simple-minded. High speed computations are the thing they do best. But never underestimate the power of arithmetic if it can be done fast enough. Donald Greenspan, formerly of the University of Wisconsin and now with the University of Texas, has recently published a book which applies the computational power of the computer to the development of discrete counterparts to many classical physical phenomena [2]. Using only arithmetic he is able to establish exactly the same laws of conversation and symmetry that exist in classical continuum mechanics. The simplicity of his approach is extraordinary.

Ideas which utilize the power of high speed arithmetic will become better understood by younger students as computer programming begins to find its way into the elementary and secondary curriculum. In fact many mathematical techniques that are classically quite complicated are extremely simple when approached with the computer.

This month, I would like to focus on a set of examples that relate very closely to the kinds of problems that students are asked to solve in mathematics courses. My objective is to contrast traditional techniques for solving mathematical problems with the way in which one might solve the same problem armed with a computer. I hope to show that problem solving with the computer has the potential for providing genuine problem solving experiences which are simple, practical, and interesting.

Lesson #8 (Beginning Students)

The Setting: The proverbial "story problem" in mathematics is the bane of most students. After many tortuous experiences of trying to match up a problem with the method they have been provided with to solve it, students come away believing, at best, that problems are solved in only one way, and at worst failing even to understand the relationship between a solution and a problem. You have probably heard students argue that a wrong result must be right because, "I used the same formula you did; how could it be wrong!"

What is woefully lacking for most students is the opportunity to see solutions for problems evolve through efforts of

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their own and to have the opportunity to experiment with relationships and patterns. This is where the computer can be a great help. For example, consider the following problem.

The Problem: Pigs and Chickens. A boy and his sister visited a farm where they saw a pen filled with pigs and chickens. When they returned home, the boy reported that he saw 18 animals in all, and his sister remembered that she had counted a total of 50 legs. How many pigs are in the pen?

The Discussion: This problem has an interesting effect on people. Far too many who try it fail because they try to remember an algebraic formula to plug into. Others successfully set up the algebraic machinery to solve it but then fail to execute the symbol manipulations properly—usually because they have forgotten at least one crucial detail. In the algebraic setting this problem can be solved by solving the set of simultaneous linear equations:

4P+2C=50
P+C=18

On the average, young kids, who have never seen algebra before, do better with this problem than adults because they look at it with an open mind.

Since this problem is presented here to illustrate more than just how to find an answer, we will convert this problem in a programming problem. This will also provide an opportunity to gain experience with the relationship between pigs, chickens, and legs which will eventually lead to insight into the problem.

The Programming Problem: Write a program which will print out the number of pigs, chickens, and the total number of legs for all combinations of pigs and chickens that add up to 18 animals.

The Algorithm: A FOR-NEXT loop can be used to compute the number of legs for each combination of pigs and chickens that add to 18. The number of chickens, of course, is 18 minus the number of pigs.

Chickens=18-Pigs

The total number of legs is clearly,

Legs=4*Pigs+2*Chickens

The program:

```
10 PRINT "PIGS";TAB(15);"CHICKENS";TAB(32);
"LEGS"
20 FOR PIGS=0 TO 18
30 CHICKENS=18-PIGS
40 LEGS=4*PIGS+2*CHICKENS
50 PRINT PIGS, CHICKENS, LEGS
60 NEXT PIGS
70 END
```

```
RUN
PIGS        CHICKENS        LEGS
 0           18              36
 1           17              38
 2           16              40
 3           15              42
 4           14              44
 5           13              46
 6           12              48
 7           11              50
 8           10              52
 9            9              54
10            8              56
11            7              58
12            6              60
13            5              62
14            4              64
15            3              66
16            2              68
17            1              70
18            0              72
```

Remarks:

1. The program above is written in Applesoft Basic. In some forms of Basic the variables PIGS, CHICKENS, LEGS will need to be shortened to P,C,L.

2. The table printout is separated into three fields by use of the comma in Applesoft Basic. Another Basic language may require the addition of the TAB function to line up the columns.

3. The pattern that appears in this printout is very revealing. Not only is the solution (7 pigs, 11 chickens) obvious but a pattern—an increase by two in the number of legs in each row—is also clear. In fact this observation can be used to find the solution quickly using only common sense:

"If all the animals were chickens (the top row) then we would be short 14 legs (50-36). So we need to change chickens into pigs. Every time a chicken becomes a pig the number of legs increases by 2. We need 7 transformations to make up the 14 legs which means we need 7 pigs, leaving 11 chickens."

To become a good problem solver, one must be aware of the patterns and relationships that exist in almost all problems. Using the computer to display these relationships not only helps make the solution easier to find and understand, but also teaches students how to use a computer to gain insight into a problem.

Additional Problems:

1. Add more flexibility to the pigs and chickens problem by allowing the number of animals to be entered and not fixed at 18.

2. Another Problem: A carpenter agrees to work under the following conditions: He is to be paid $10 a day for his work for every day he works, but will be fined $12 for every day he misses. At the end of 30 days he has worked just enough days so as not to lose anything. Write a program which will print out the number of days worked, days absent, net pay. What is the solution?

Lesson #8 (Intermediate Students)

The Setting: The typical mathematics text does an honest job of trying to explain the origins of most algorithms before it highlights the essential part in bold type and assigns 25 problems that use it. The teacher may also do a conscientious job explaining the development of the algorithm from fundamental principles. But the student quickly learns that all you really have to know is how to plug the correct numbers into the right spots to get the assignment done. Why the algorithm works is lost in the mystery of algebraic magic.

For example, consider the quadratic formula: The roots of the quadratic equation $ax^2 + bx + c = 0$ can be expressed by the quadratic formula

$$\frac{b \pm \sqrt{b^2 - 4ac}}{2a}$$

A typical application of this formula might be to find the values of x where the curve $y = x^2 + x - 1$ crosses the x axis ($y = 0$). By simply substituting the coefficients into the quadratic formula we have:

$x = (-1 \pm \sqrt{5})/2$.

However, very little is learned about problem solving or about the meaning of the solution in the process. To most students the numbers that pop out of the quadratic formula are meaningless. It is merely a routine operation that must be performed in order to get the answers in the back of the book.

But there is a strategy which can be implemented on the computer that is completely elementary and well within the ability of intermediate students to program. It is called bisection.

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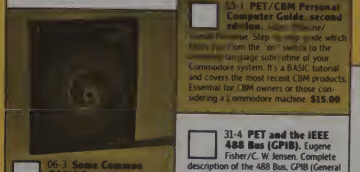

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number that lies between 0 and 100 by asking questions that can be answered either yes or no. Using the bisection strategy one can reduce the possibilities for the mystery number in half by asking: "Is the number greater than 50?" If the answer is yes, then the number has been trapped in the interval (51,100). If the answer is no, then the number is in the interval (0,50). The same strategy is repeated again on the reduced interval which contains the mystery number. In this way the size of the interval which contains the unknown number is cut in half at each stage until finally one possibility remains. This is illustrated as follows:

Trial #	Size of Interval
0	100
1	50
2	25
3	13
4	7
5	4
6	2
7	1

Including the final guess which names the mystery number, it requires at most eight questions to find the solution using the bisection technique.

This technique is also the basis of a procedure that can be used to find the real roots of any smooth function F(X). We will use the quadratic function $X^2 + X - 1$ to illustrate this idea. First, consider a table of values for this function.

X	$X^2 + X - 1$
-2	1
0	-1
1	1

This table tells us that the graph of the function is above the X axis at -2, below the X axis at 0, and above the X axis at 1. Since the quadratic function is a smooth graph and cannot make any sudden jumps in its graph, there must be a point in the interval (-2,0) where it crosses the X axis (i.e. $X^2 + X - 1 = 0$). The same must be true for the interval (0,1) (see Figure 1). The point at which this happens is called a root of the function and we can find it by using the bisection technique.

The Problem: Write a computer program that will find the roots of the quadratic function $X^2 + X - 1$ by the method of bisection. Allow the user to input values for A and B and let the program test whether the interval (A,B) contains a root.

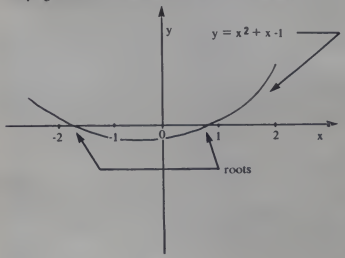

Figure 1.

The Discussion: The key to the bisection strategy is very simple. Suppose a smooth function F(X) has a different sign (+ or -) at two points X = A and X = B. For the sake of this discussion, assume that F(A) > 0 and F(B) < 0. Then somewhere between A and B, F(X) must be zero. The unknown region can be cut in half by picking the midpoint C = (A + B)/2. Call C a trial root. IF F(C)=0 then the trial root is indeed a root and we are done. If not, then either F(C) > 0 or F(C)< 0. IF F(C) > 0, then the root must be contained in the interval (C, B) (remember F(B)< 0). IF F(C) < 0 then the root must be in the interval (A,C) (remember F(A) > 0). In the first case, replace A with C and in the second case, replace B with C. Thus, in either case A or B is replaced with a new value C = (A + B)/2 so that:

(1) the region (A,B) is cut in half, and

(2) the condition that F(A) and F(B) have different signs is maintained.

We are now in a position to repeat the bisection strategy on the smaller interval (A,B). As this procedure continues, the interval (A,B) decreases in size closing in on both sides on the root. It can be stopped whenever a desired degree of accuracy is achieved.

The Algorithm: Functions are defined in Basic by use of DEF FNF (X). For the quadratic function in question we have:

DEF FNF(X) = X*X + X - 1

We must test the function initially at A and B to make sure they have different signs. This is done with the SGN ( ) function:

SGN(X) = 1 if X > 0
SGN(X) = 0 if X = 0
SGN(X) =-1 if X < 0

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Thus, to begin using the bisection mehtod we must have:

SGN(FNF(A)) < > SGN(FNF(B)).

The SGN function is also used to check whether A or B is replaced with C = (A + B)/2.

IF SGN(FNF(C)) = SGN(FNF(A)) THEN A=C ELSE B=C

The absolute value function ABS(X) is used to test the size of the interval (A,B). To be accurate to 5 decimal places in an absolute sense we use the test:

IF (ABS(A-B) > .00001 THEN (continue bisecting) ELSE (print the approximate root C.)

The Program:

```
10 PRINT "BISECTION METHOD FOR FINDING ROOTS"
20 DEF FNF(X)=X*X + X - 1
30 INPUT "ENTER A,B = ";A,B
40 PRINT "TRIAL ROOT",TAB(20),"FUNCTION VALUE"
50 E=.00001
60 IF SGN(FNF(A))<>SGN(FNF(B)) THEN 90
70 PRINT "THE SIGNS ARE THE SAME, TRY AGAIN."
80 GOTO 30
90 C=(A+B)/2
100 IF FNF(C)=0 THEN 140
110 IF SGN(FNF(C))=SGN(FNF(A)) THEN A=C ELSE B=C
120 PRINT C,TAB(20),FNF(C)
130 IF ABS(A-B)>E THEN 90
140 PRINT "ROOT = ";C
150 END

BISECTION METHOD FOR FINDING ROOTS
ENTER A,B = 0,1
TRIAL ROOT              FUNCTION VALUE
 .5                      -.25
 .75                     .3125
 .625                    .015625
 .5625                   -.1210937
 .59375                  -.0537109
 .609375                 -.0192871
 .6171875                -.0018921
 .62109375               .0068512
 .61914065               .0024758
 .6181641                .000291
 .6176758                -.0008008
 .61791995               -.000255

BISECTION METHOD FOR FINDING ROOTS
ENTER A,B = -2,0
ROOT =  -1.6180345

 .61804205               .000018
 .6179981                -.0001185
 .61801155               -.0000502
 .6180268                -.0000161
 .61803445               .000001
ROOT =  .61803445
```

Remarks:

1. The roots computed by the quadratic formula are $(-1 \pm \sqrt{5})/2$, which can be approximated by .618034 and - 1.618034.

2. The quadratic formula is only good for finding roots of quadratic funtions while the bisection technique can be used with any function that can be expressed in a computer language.

3. The absolute error of E = .00001 is fine for demonstration purposes, but it is not satisfactory in general. If a root is very small, for example .0002, then testing for errors of .00001 will yield an answer that is correct to only 2 significant places. To be sure of having an accuracy of at least 5 significant figures, use the relative error

E = .000001 * (ABS(A) + ABS(B))/2.

Additional Problems:

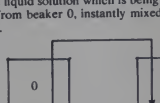
1. Replace the quadratic function X*X + X - 1 with the sine function SIN(X). The sine function is zero at $X = \pi$. Use the bisection program to obtain an approximation to π by finding a root for the sine function between 2 and 4.

2. The bisection program can also be used to find where functions intersect. For example, where does the curve Y = X intersect the curve Y = COS(X)? This happens, of course, when X = COS(X) or, expressed another way, when COS(X) - X = 0. Thus, finding the roots of the difference between the two curves is equivalent to finding where they meet. Find all points where these two functions meet.

3. Finding the fifth root of 2 is equivalent to solving the problem $X^5 = 2$. This is equivalent to finding a roots of the function $X^5 - 2 = 0$. Use the bisection program to find $\sqrt[5]{2}$.

Lesson #8 (Advanced Students)

The Setting: A student working on a chemistry experiment recently has a question about a liquid dilution problem. A one-liter beaker of a concentrated solution was to be diluted with one liter of water. If the water had been added all at once, then the concentration of the liquid substance would be cut in half. But in this experiment the water was to be added very slowly, mixed completely with the concentrated liquid, and continuously discarded, so that only one liter was kept at all times. This can be seen by visualizing a full beaker (1) of a liquid solution which is being constantly diluted with water from beaker 0, instantly mixed, and the overflow discarded.



What is the concentration of the liquid after it has been diluted in this fashion with one liter of water?

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Solve It, continued...

Without the computer, this problem involves setting up the proper differential equation.The student who asked about the problem had no idea how to set up such a problem much less how to solve it. With a little knowledge of Basic and a computer this problem is relatively easy to understand and solve.

Problem 1: Write a computer program which simulates the dilution of the liter of a concentrated solution with one liter of water. The dilution should be carried out gradually so that a small quantity of water is added to the liquid solution, instantly mixed, and the same quantity of mixed solution discarded. What is the final concentration of the diluted solution if the initial concentration is C?

The Discussion: In the process of programming the computer to solve this problem, we actually see what is happening at each stage in the dilution. In fact, if we can compute the new concentration after the addition of a small quantity of water, then we can easily find the final concentration by simply repeating the process until all the water is added. Let M stand for the number of milliliters of water that are mixed with the dilution. (One liter = 1000 milliliters.) If M is small, then the dilution process is nearly continuous. We begin with one liter of the solution with concentration C. After adding M milliliters of water, the concentration is reduced to

C/(1 + M/1000)).

Replace the old concentration with the new by setting

C = C/(1 + M/1000).

This process of adding water, mixing the solution, and discarding an equal amount of solution must be repeated 1000/M times before the entire liter of water is used up. The resulting concentration C is a good approximation to the solution for the continuous dilution program.

The Program:

```
10 PRINT "CONTINUOUS DILUTION PROBLEM"
20 PRINT "============================"
30 INPUT "ENTER THE INITIAL CONCENTRATION      >>> ",C
40 INPUT "MILLILITERS OF WATER ADDED EACH STEP >>> ",M
50 N=1000/M                \ REM N = THE NUMBER OF STEPS
60 D=M/1000                \ REM D = WATER IN LITERS
70 T = 0                   \ REM T = MILLILITERS ADDED
80 PRINT "MILLILITERS ADDED",TAB(20),"CONCENTRATION"
90 FOR I=1 TO N
100 PRINT TAB(3),T,TAB(20),C
110   C=C/(1+D)
120 T=T+M
130 NEXT I
140 PRINT TAB(3),T,TAB(10),"SOLUTION =",TAB(20),C
```

```
 CONTINUOUS DILUTION PROBLEM
 ===========================
ENTER THE INITIAL CONCENTRATION      >>> 1
MILLILITERS OF WATER ADDED EACH STEP >>> 100
MILLILITERS ADDED    CONCENTRATION
     0                1
     100              .90909091
     200              .82644628
     300              .7513148
     400              .68301345
     500              .62092132
     600              .56447393
     700              .51315812
     800              .46650738
     900              .42409762
     1000   SOLUTION = .38554329
MILLILITERS OF WATER ADDED EACH STEP >>> 50
MILLILITERS ADDED    CONCENTRATION
     1000   SOLUTION = .37688949
MILLILITERS OF WATER ADDED EACH STEP >>> 10
MILLILITERS ADDED    CONCENTRATION
     1000   SOLUTION = .36971125
MILLILITERS OF WATER ADDED EACH STEP >>> 1
MILLILITERS ADDED    CONCENTRATION
     1000   SOLUTION = .36806335
MILLILITERS OF WATER ADDED EACH STEP >>> .5
MILLILITERS ADDED    CONCENTRATION
     1000   SOLUTION = .36797136
```

Remarks

1. The last four runs were made with the intermediate print out deleted.

2. Notice how little the final concentration changes in the last three runs even though the number of steps has increased 100 times.

3. The limiting value of the concentration as M approaches zero would be the exact continuous solution.

4. Those familiar with elementary differential equations will be able to understand the following argument which leads to an exact continuous solution:

Let C(I) equal the concentration at step I. Then the relationship we are using to express the new concentration from the old at each step can be written

C(I) = C(I-1)/(1 + D).

Using algebra we can rewrite this as

C(I)-C(I-1) = -D*C(I).

Let ΔC = C(I)-C(I-1), and ΔX = D. We can rewrite the expression again to read

$$\frac{\Delta C}{\Delta X} = -C.$$

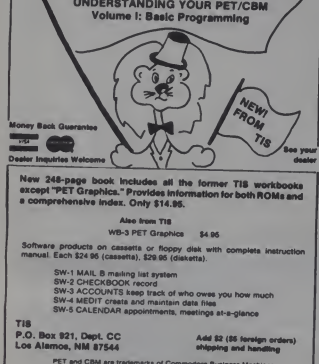
This difference equation leads to the differential equation

$$\frac{dC}{dX} = -C.$$

The solution of this equation is well known and given by

$C = C_0\, e^{-x}$

where C_0 is the initial concentration. Substituting C=1 and



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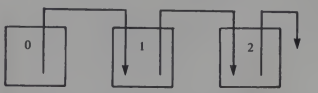
X=1 into this expression, we get the exact continuous solution

C = .36788.

Problem 2: Expand Problem 1 to include a second concentrated solution which is diluted with the discarded solution from the first concentrated solution. Write a program which will simulate the dilution of each substance and find the final concentration. The initial concentration and and the step size should be entered by the user.



The Algorithm: Let C1 and C2 be the concentration of the first and second solution respectively. If D is the number of liters added in each step, then the concentration of the first liquid is diluted at each step to give

C1=C1/(1+D)

as before. D liters of this solution is passed on the new concentrated solution and changes its concentration to

C2=(C2+D*C1)/(1+D).

The D*C1 is the contribution from the previous beaker.

The Program:

```
10 PRINT "CONTINUOUS DILUTION PROBLEM 2 "
20 PRINT "=============================="
30 INPUT "THE INITIAL CONCENTRATION OF SOLUTION 1 >>> ";C1
40 INPUT "THE INITIAL CONCENTRATION OF SOLUTION 2 >>> ";C2
50 INPUT "MILLILITERS OF WATER ADDED EACH STEP >>> ";M
60 N=1000/M             \ REM N = THE NUMBER OF STEPS
70 D=M/1000             \ REM D = WATER IN LITERS
80 T = 0                \ REM T = MILLILITERS ADDED
90 PRINT "MILLILITERS ADDED",TAB(20),"SOLUTION 1",
   TAB(35),"SOLUTION 2"
100 FOR I=1 TO N
110 PRINT TAB(3),T,TAB(20),C1,TAB(35),C2
120    C1=C1/(1+D)
130    C2=(C2+D*C1)/(1+D)
140 T=T+M
150 NEXT I
160 PRINT TAB(3),T,TAB(10),"ANSWER = ",TAB(20),C1,
    TAB(35),C2
170 END
```

```
CONTINUOUS DILUTION PROBLEM 2
=============================
THE INITIAL CONCENTRATION OF SOLUTION 1 >>> 1
THE INITIAL CONCENTRATION OF SOLUTION 2 >>> 1
MILLILITERS OF WATER ADDED EACH STEP >>> 100
MILLILITERS ADDED    SOLUTION 1      SOLUTION 2
      0                 1               1
      100               .90909091       .99173555
      200               .82644628       .97670927
      300               .7513148        .95621891
      400               .68301345       .93138209
      500               .62092132       .90315838
      600               .56447393       .87236888
      700               .51315812       .83971325
      800               .46650738       .80578554
      900               .42409762       .77108664
      1000   ANSWER =   .38554329       .73603725

MILLILITERS OF WATER ADDED EACH STEP >>> 50
MILLILITERS ADDED    SOLUTION 1      SOLUTION 2
      1000   ANSWER =   .37688949       .73583189

MILLILITERS OF WATER ADDED EACH STEP >>> 10
MILLILITERS ADDED    SOLUTION 1      SOLUTION 2
      1000   ANSWER =   .36971125       .73576197

MILLILITERS OF WATER ADDED EACH STEP >>> 1
MILLILITERS ADDED    SOLUTION 1      SOLUTION 2
      1000   ANSWER =   .36806335       .73575889

MILLILITERS OF WATER ADDED EACH STEP >>> .5
MILLILITERS ADDED    SOLUTION 1      SOLUTION 2
      1000   ANSWER =   .36797136       .73575901
```

Remarks:

1. The last four runs were made with the intermediate print out deleted.

2. The limiting values for the concentrated solutions that result when M approaches zero would be the exact continuous solutions.

3. Those familiar with differential equations will be able to understand the following argument which leads to an exact continuous solution.

As shown in the remarks following Problem 1, the concentration in the first solution satisfies the differential equation

$$\frac{dC1}{dX} = -C1.$$

The change in the concentration of the second can be derived by rewriting line 130 in the above program as

C2(1) = (C2(I-1) + D* C1(I))/(1 + D).

Let $\Delta C2 = C2(I)-C2(I-1)$ represent the change in the concentration after each step in the dilution process. Let $\Delta X = D$ and write the last expression in terms of the difference equation

$$\frac{\Delta C2}{\Delta X} = C1 - C2.$$

This leads to the second differential equation

$$\frac{dC2}{dX} = C1 - C2.$$

The two differential equations form a linear system of differential equations with the following solutions

$$C1 = C1_0 e^{-x}$$

$$C2 = C1_0 X e^{-x} + C2_0 e^{-x}.$$

When X=1, $C1_0 = 1$ and $C2_0 = 1$, we have C1 = .36788, C2 = .73576. □

References

[1] *Priorities In School Mathematics*, National Council of Teachers of Mathematics, funded by the National Science Foundation, directed by Alan Osborne. Available from the ERIC Documentation Reproduction Service, P.O. Box 190, Arlington, VA 22210.

[2] Greenspan, Donald, *Arithmetic Applied Mathematics*. Pergamon Press, Elmsford, New York, 1980.

"I believe Franklin is having another brainstorm."

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CIRCLE 152 ON READER SERVICE CARD

TREE

Evan Heit

You are a tree. As a tree, your primary goal in the forest is to survive. But you are a human tree. As you know, human trees are very special trees with very special goals. You *must* be the tallest tree in the forest. At all costs. Even if some of your friends get hurt in the process. If you're impulsive, you'll try to shoot way up in the air with no root or leaf system. And die. But if you're a wise tree, you'll grow upwards slowly, developing leaves and roots to supply you with more energy. So you can shoot up and be the tallest tree in the forest.

The Situation

You are a tree in the Floppy Forest. The Floppy Forest Social Director, Mr. Leaf Erickson, decides to hold a contest for all the little sprouts in the Forest. The Who-Can-Grow Five-Meters-First? Contest. Only you and four other seedlings are brave enough to try. At the beginning of the contest, you receive a letter from the local utility company, Con EdiSUN:

YOU NOW HAVE 100 UNITS OF ENERGY. HOW MUCH DO YOU WANT TO ALLOW THIS YEAR FOR:

1. PROTECTION AGAINST BUGS AND DISEASE?_____
2. UPWARD GROWTH?_____
3. LEAF GROWTH?_____
4. DOWNWARD ROOT GROWTH?___
5. HORIZONTAL ROOT GROWTH?__

You quickly fill out the form. You allow 20 units for your long climb upward and twenty five units for the leaves, since your energy supply from now on will be based totally on the size of your leaf and root systems. You allow 15 units for downward root growth, twenty five for horizontal root growth, and the rest for protection. You seal the envelope, lick the stamp, and run down to the post office. And wait. And grow.

Evan Heit, 3530-15 Long Beach Rd., Oceanside, NY 11572.

The Game

Tree is for up to five humans. The computer will play for any tree not controlled by a human. You start with 100 units of energy. Future energy supplies are based on the size of your root and leaf systems. You must have leaves *and* roots in order to make energy. Leaves without roots give no energy; roots without leaves are just as useless. Vertical growth supplies no energy, but serves as a base for horizontal growth. There is a 15% chance every year of damage due to disease or insects. The more you put away for protection, the less you will be damaged. The first tree to reach five meters wins.

The Program

Tree is written for the Commodore PET with 8K or more memory. Converting the program and graphics to other computer systems is possible. Everything is done in tiny subroutines to make things easier for you to understand (easier for me to write!)

Notice that I almost always use extra-long variable names to express each variable's job. Those who don't get their jollies by typing extra stuff can reduce wear and tear on their fingers by typing a line like

```
123  WIJABU(FOO)=VAL(BASKETBALL$(6,BAH))
```

as

```
123 WI(FO)=VAL(BA$(6,BA)).
```

Here's a blow by blow description of the program:

100-998 Calls the various subroutines of the program
450 Checks for the end of the game
950 Goes back for another year
998 Lines like this don't have to be typed in
1000-1998 Initialization
1005 DIM's arrays
ABOVE$(15) Fifteen lines on screen for above-ground growth
BELOW$(15) Eight lines on screen for below-ground

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*NOTE: Old DOS doesn't recognize three of the commands.

Those are just 3 of the important commands—and there are 7 more beauties—on your Disk-O-Pro that have never been available previously to PET/CBM users. (Skyles does it again!)...Beauties like the softtouch key **(SET)** which allows you to define a key to equal a sequence of up to 80 keystrokes; like **SCROLL** whereby all keys repeat as well as slow scrolling and extra editing features; like **BEEP** which allows you to play music on your PET.

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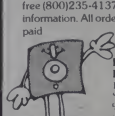

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CIRCLE 223 ON READER SERVICE CARD

Tree, continued...

TURN(5,5) Each tree's turn in five categories
ENERGY(5) Each tree's energy
HEIGHT(5), RHEIGHT(5) Height above and below ground
1015 Fills ABOVE$ & BELOW$ with 39 spaces
1035 NH is the number of humans playing
1065 FIRST determines who goes first
1070 Everybody starts with 100 units of energy
2000-2998 Plan each year's turn

2250 Human inputs her turn
2400 Display human's energy
2500 Computer makes its turn

3000-3998 BUGS & DISEASE
3015 Fifteen percent chance of damage
3020 Disease or insects?
3030 How much damage?
3035 Did tree allow enough for protection?
3040 Reduce unprotected trees

4000-4998 Above-ground growth

4013 Winner?
4250 Vertical growth
4255 How much energy to grow 1/3 of a meter?
4262 Don't grow upwards too fast!
4500 Horizontal growth
4520 Tree grows leaves—unless someone's in the way

5000-5998 Below-ground growth (see above)

6000-6998 Display forest
6025 Print stem and leaves of tree
6050 Print roots of tree

7000-7998 How much energy for each tree?
7010 Less roots or less leaves?
7014 How much energy?
7018 Reduce old parts of tree

8000-8998 A winner!!
8010 Display trees
8020 And the winner is...
8025 Game over!

9000-9998 INPUT ROUTINE—a return-proof input routine that won't drop you into Basic

10000-10090 Here we decipher those inscrutable cursor control characters (you don't have to type this in)

Back to Reality

Your height is about 4½ meters, but your buddy next-door is a little bit taller. DAMAGE DUE TO DISEASE! Next year your damaged opponent doesn't budge at all, but since you put energy aside for protection, you grow a full meter with no damage. YOU WIN! □

```
0 REM ############################
1 REM #  *TREE*  PROGRAMMED BY     #
2 REM #  EVAN K. MEIT              #
3 REM #  3530-15 LONG BEACH ROAD   #
4 REM #  OCEANSIDE, NY 11572       #
5 REM #  (516) 536 8063           #
6 REM #  AS OF OCTOBER 4,1980     #
7 REM #  FOR ANY PET 8K & UP      #
8 REM ############################
9
100 GOSUB1000 REM INITIALIZATION
200 GOSUB2000 REM TURNS
300 GOSUB3000 REM INSECTS & DISEASE
400 GOSUB4000 REM ABOVE GROUND GROWTH
450 IF BYEBYE=1 THEN END
500 GOSUB5000 REM BELOW GROUND GROWTH
600 GOSUB6000 REM DISPLAY
700 GOSUB7000 REM AVAILABLE ENERGY
950 GOTO200
998
1000 REM"INITIALIZATION
1005 DIM ABOVE$(15),BELOW$(8),TURN(5,5),ENERGY(5),HEIGHT(5),RHEIGHT(5)
1006 DIM SIZE(5,2)
1010 PRINT"▯";TAB(17);"*TREE*"
1015 FORJ=1TO15 FORK=1TO3 ABOVE$(J)=ABOVE$(J)+"                    " NEXT NEXT
1020 FORJ=1TO8 FORK=1TO3 BELOW$(J)=BELOW$(J)+"                    " NEXT NEXT
1025 J=RND(-TI) REM RANDOMIZE
1030 PRINT"▯▯▯HOW MANY HUMANS ARE PLAYING (0-5)"; GOSUB9000 NH=IN
1035 NH=INT(ABS(NH)) IFNH<0ORNH>5THEN1030
1060 PRINT"▯▯▯IF FIRST TREE TO REACH 5 METERS WINS!"
1065 FIRST=INT(2*RND(1)+1) REM ORDER OF TURNS
1070 FORJ=1TO5 ENERGY(J)=100 NEXT
1075 FORJ=1TO2000 NEXT
1080 RETURN
1998
2000 REM"TURNS
2005 PRINT"▯▯"
2010 YEAR=YEAR+1
2015 FIRST=3-FIRST
2020 IFFIRST=1THEN2050
2025 FORJ=1TO5
2030 IFJ>NHTHENGOSUB2500 OOTO2040
2035 GOSUB2250
2040 NEXTJ
2045 RETURN
2050 FORJ=5TO1STEP-1
2055 IFJ>NHTHENGOSUB2500 OOTO2065
2060 GOSUB2250
2065 NEXTJ
2070 RETURN
2250 REM HUMAN TURN
2255 PRINT"▯▯PLAYER";J;QQQ=ENERGY(J) GOSUB2400
2260 PRINT"HOW MUCH FOR PROTECTION"; GOSUB9000 TURN(J,1)=IN
2265 QQQ=QQQ-IN IFQQQ<0THEN2250
2270 GOSUB2400 PRINT"HOW MUCH FOR UPWARD GROWTH"; GOSUB9000 TURN(J,2)=IN
2275 QQQ=QQQ-IN IFQQQ<0THEN2250
2280 GOSUB2400 PRINT"HOW MUCH FOR LEAF GROWTH"; GOSUB9000 TURN(J,3)=IN
2285 QQQ=QQQ-IN IFQQQ<0THEN2250
2290 GOSUB2400 PRINT"HOW MUCH FOR DOWNWARD ROOT GROWTH"; GOSUB9000
2295 TURN(J,4)=IN QQQ=QQQ-IN IFQQQ<0THEN2250
2300 GOSUB2400 PRINT"HOW MUCH FOR HORIZONTAL ROOT GROWTH"; GOSUB9000
2305 TURN(J,5)=IN QQQ=QQQ-IN IFQQQ<0THEN2250
2310 PRINT"▯▯▯ANY CORRECTIONS▯"; GOSUB9000 IFLEFT$(IN$,1)="Y"THEN2250
2315 RETURN
2400 REM DISPLAY ENERGY
2405 PRINT"▯▯▯YOU NOW HAVE";QQQ;"▯▯ UNITS OF ENERGY.▯▯"
2410 RETURN
2500 REM COMPUTER TURN
2505 E1=ENERGY(J)
2510 TURN(J,2)=(E1/4)*RND(1)*E1/6
2515 E1=E1-TURN(J,2)
2520 TURN(J,3)=(E1/4)*RND(1)*E1/6
2525 E1=E1-TURN(J,3)
2530 TURN(J,4)=(E1/4)*RND(1)*E1/6
2535 E1=E1-TURN(J,4)
2540 TURN(J,5)=(E1/3)*RND(1)*E1/2
2545 E1=E1-TURN(J,5)
2550 TURN(J,1)=E1
2555 RETURN
2998
3000 REM"INSECTS & DISEASE
3005 IFYEAR=1THENRETURN REM NO DISEASE IN FIRST YEAR
3010 YUCK$=""
3015 IFRND(1)<.85THENRETURN REM 15% CHANCE
3020 YUCK$="DISEASE" IFRND(1)<.5THENYUCK$="INSECTS"
3025 FORJ=1TO5 HEIGHT(J)=HEIGHT(J)-1 NEXT
3030 DAMAGE=60*(RND(1)+2)
3035 FORJ=1TO5 IF(<TURN(J,1)*.5)*2)>=DAMAG THEN3045
3040 RATIO=DAMAGE/(<TURN(J,1)*.5)*2) HEIGHT(J)=HEIGHT(J)/RATIO
```

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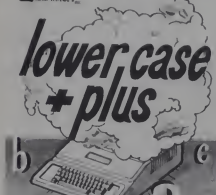

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Tree, continued...

```
3041 FORK=2TO5*TURN(J,K)=TURN(J,K)/RATIO NEXT
3045 NEXTJ
3050 RETURN
3990
4000 REM"ABOVE GROUND GROWTH
4001 IFFIRST=1THEN4030
4005 FORJ=1TO5
4010 GOSUB4250 REM VERTICAL GROWTH
4013 IFBYEBYE=1THENRETURN
4015 GOSUB4500 REM HORIZONTAL GROWTH
4020 NEXTJ
4025 RETURN
4030 FORJ=5TO1STEP-1
4035 GOSUB4250
4037 IFBYEBYE=1THENRETURN
4040 GOSUB4500
4045 NEXTJ
4050 RETURN
4250 REM VERTICAL GROWTH
4255 NEEDED=14+12#HEIGHT(J)
4256 OLD#=HEIGHT(J)
4260 HEIGHT(J)=OLD+TURN(J,2)/NEEDED
4262 IFHEIGHT(J)-OLD)3THENHEIGHT(J)=OLD+3 TURN(J,3)=TURN(J,3)*2
4263 IFHEIGHT(J)<1THENRETURN
4265 IFHEIGHT(J)>=15THEN8000
4270 FORK=1TOHEIGHT(J)
4275 ABOVE#(K)=LEFT$(ABOVE#(K),1+6*J)+CHR$(48+J)+MID$(ABOVE$(K),3+6*J)
4280 NEXTK
4285 RETURN
4500 REM HORIZONTAL GROWTH
4505 IFHEIGHT(J)<1THENRETURN
4510 H##HEIGHT(J) NEEDED=6+H
4515 WIDTH=TURN(J,3)/NEEDED+.5 IFWIDTH>5THENWIDTH=5
4518 IFWIDTH<1THENRETURN
4520 FORK=(2.5+6*J)-WIDTHTO(3+6*J)+WIDTH
4525 IFMID$(ABOVE$(H),K,1)<>" "THEN4595
4529 SIZE(J,1)=SIZE(J,1)+1
4530 ABOVE$(H)=LEFT$(ABOVE$(H),K-1)+CHR$(48+J)+MID$(ABOVE$(H),K+1)
4535 NEXT
4540 RETURN
4990
5000 REM"BELOW GROUND GROWTH
5001 IFFIRST=1THEN5030
5005 FORJ=1TO5
5010 GOSUB5250 REM VERTICAL GROWTH
5015 GOSUB5500 REM HORIZONTAL GROWTH
5020 NEXTJ
5025 RETURN
5030 FORJ=5TO1STEP-1
5035 GOSUB5250
5540 RETURN
5990
6000 REM"DISPLAY
6005 IFVUCK$="THEN6020
6010 PRINT"[illegible]AMAGE DUE TO ";VUCK$
6015 FORJ=1TO4000 NEXT
6020 PRINT"[illegible]";
6025 FORJ=1TO1STEP-1
6030 PRINTABOVE$(J)
6035 NEXTJ
6040 SCALE$="[illegible]"
6043 PRINT"[illegible]";SCALE$ PRINT"[illegible]";TAB(36);SCALE$
6045 PRINT"[illegible]"
6050 FORJ=1TO8 PRINT"[illegible]";BELOW$(J) NEXT
6055 PRINTTAB(16);"YEAR";YEAR;
6060 FORJ=1TO9000 NEXT
6065 RETURN
6990
7000 REM"AVAILABLE ENERGY
7005 FORJ=1TO5
7010 LOW=SIZE(J,1) IFSIZE(J,2)<LOWTHENLOW=SIZE(J,2)
7014 ENERGY(J)=INT(16#LOW+YEAR+HEIGHT(J)+.5)
7016 IFJ>NHTHENENERGY(J)=ENERGY(J-1)
7018 FORK=1TO2 SIZE(J,K)=SIZE(J,K)*.75 NEXT
7020 NEXTJ
7025 RETURN
7990
8000 REM"WINNER!
8005 HEIGHT(J)=15 J1=J
8010 GOSUB6000
8011 PRINT"[illegible]"
8015 PRINT"IT IS YEAR",YEAR
8020 PRINT"[illegible]PLAYER",J1,"WINS !"
8025 BYEBYE=1
8030 RETURN
8990
9000 REM"INPUT ROUTINE
9005 INPUT"[illegible]",IN$
9010 IN=VAL(IN$)
9015 RETURN
9990
10000 REM"[illegible] REVERSE ON
10010 REM"[illegible] REVERSE OFF
10020 REM"[illegible] CLEAR SCREEN
10030 REM"[illegible] CURSOR HOME
10040 REM"[illegible] CURSOR DOWN
10050 REM"[illegible] CURSOR UP
10060 REM"[illegible] CURSOR RIGHT
10070 REM"[illegible] CURSOR LEFT
10080 REM WIJABU !!
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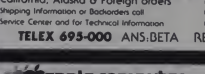

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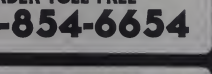

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CIRCLE 140 ON READER SERVICE CARD

It seems that interstellar trade takes us back to the days of the Yankee Clipper. Return with us now to those thrilling days of tomorrow...

Historical Background

Early in the 26th century, the 50XFTL drive was developed. This drive, when properly installed on a spaceship, would cause a controlled warping of space enabling the spaceship to travel at fifty times the speed of light (50XFTL). Massive colonization of the nearby stars took place in the following two centuries, due to the crowded conditions on inhabitable planets of the solar system and the development of this drive.

By the mid 29th century, large orbiting space stations (starports) were constructed at the ten most populated star systems. These starports had facilities for docking and refueling starships as well as massive cargo storage capability. The construction of these starports was closely paralleled by a simplification of starship design. With the advent of the starports, it was no longer necessary for a starship to land on a planet. This eliminated the need for atmospheric streamlining, as well as the large reaction engines required to lift the starship from the planetary surface, while it substantially increased the cargo hold of starships.

The type of cargo which will be available for purchase at any particular starport is difficult to predict, since most of the cargos did not originate at that star system, but were brought there by other merchant starships. Coordination of trade routes to guarantee cargo availability at a starport had never occurred due to the independent nature of the star merchants and the slow communication between the star systems.

As trade developed between the starports, each starport was assigned a trade classification. Although the trade classification is useless in determining which cargos might be available for purchase, it is extremely useful in predicting the price of the cargo.

Game Description

When you play Star Merchant you will find yourself commander of a merchant starship. Your goal is to make enough money by trading cargos to stay in business and regain your initial investment for the lease of the starship. There are ten different starports where trade is conducted and 36 different types of cargos which may be traded. A brief set of instructions for the game is listed in lines 90-260 of the program and is also listed in the sample run.

The different types of cargos range from agricultural produce and raw materials to industrially produced items, such as weapons and machinery. The price at which these cargos will be traded is dependent upon the trade classification of the starport where the item is being traded. For example, farm machinery might bring top dollar at a starport with an agricultural trade class, whereas the price of grain there will probably be very low.

The starport names, distances and directions listed for command 5 (LIST STARPORTS) were taken from the actual names, distances and direction of some of the stars closest to Earth. The distance and direction will not always be completely accurate, since for this game the stars are represented on two dimensions, as opposed to three dimensions of actual space. (There is assumed to be a good scientific reason for this.—Ed.)

Ship expenses must be paid every time a new starport is reached. If your account becomes negative after paying these expenses, you must sell enough cargo to make it positive before you can leave the starport. If you do not have enough cargo to do this, you are out of business and the game ends.

The expenses which must be paid consist of a docking fee, fuel expenses, and crew salary. The docking fee will always be 50,000 credits. The fuel expenses are directly proportional to the distance traveled from the last starport. The cost of fuel per lightyear is 100,000 credits. The crew's salary is based on an annual salary of 500,000 credits and the amount of ship time that has passed since the crew was last paid. Ship time increases approximately .02 years a week for each lightyear traveled and approximately .003 years a day for each cargo transaction.

As your fortune grows, the probability increases that the crew will go on strike for a higher salary. When a strike occurs the crew presents their salary demands and you are asked for a counter-offer. The probability that your counter-offer will be accepted depends upon the amount that you offer and the number of counter-offers that have been rejected previously. Once the crew has rejected ten counter-offers, they will accept

Lloyd Johnson, 11847 Silhouette Pl., Florissant, MO 63033.

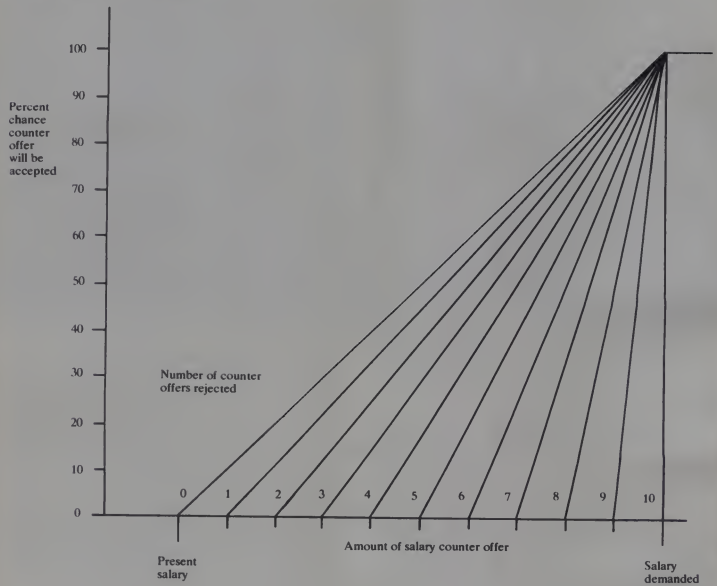

Figure 1.

only their original salary demands or higher. For this reason an early strike settlement is desirable.

The lease on your ship will expire after two years of ship time. At this time you will be asked to renew your lease if you have enough money. It will cost 2,000,000 credits for another two-year lease. Should you decide not to renew your lease, or if you do not have enough money for lease renewal, the game will end, and the game results will be displayed.

A copy of the program on cassette for the TRS-80 Level II computer may be obtained from me for $10.

Program Description

This program is written in H-P Basic. With little or no modification it should work on most machines. To aid in debugging, a detailed description of the program and the variables follows.

The program is arranged into five main sections. These sections and their corresponding subsections are listed as follows:

1. Initialize section. Lines 50-630.
2. Main logic section. Lines 640-880.
3. End program section. Lines 890-1030.
4. Subroutine section. Lines 1040-3640.
   - 4.1 Strike. Lines 1040-1230.
   - 4.2 List cargo in hold. Lines 1250-1410.
   - 4.3 List cargo for sale. Lines 1420-1580.
   - 4.4 Buy cargo. Lines 1590-1890.
   - 4.5 Sell cargo. Lines 1900-2040.
   - 4.6 List starports. Lines 2050-2140.
   - 4.7 Travel to new starport. Lines 2150-3370.
   - 4.8 List commands. Lines 3380-3460.

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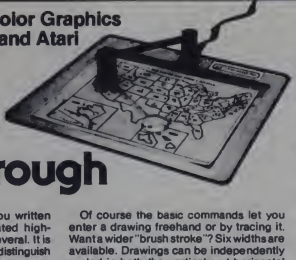


Graphics Breakthrough

How many programs have you written that would benefit from animated high-resolution graphics? Probably several. It is this kind of dramatic graphics that distinguish outstanding programs from ordinary ones. But if you've ever agonized for hours or days just to get one image perfected, you're probably not anxious to do it again. Now there's a better way.

New Graphics Entry System

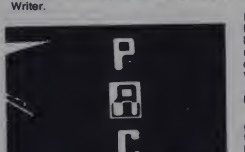
Today there is a new graphics system available that is not only amazingly user-oriented but surprisingly economical. Called VersaWriter, it starts with an ingeniously simple entry board consisting of a 14" X 12" high impact plastic bed with a tough clear plastic overlay sheet. The original drawing or diagram is fastened with masking tape to the plastic bed and then covered with the clear sheet. Instead of using a light pen or complicated electronic X-Y head, the VersaWriter uses a double jointed arm attached to the top of the entry board at one end and a magnifying lens with crosshairs at the other end. The VersaWriter resembles a draftsman's pantograph on a smaller scale.

At each joint in the arm of the VersaWriter is a potentiometer. A cable from these pontentiometers connects to the paddle input of the computer. No special interface electronics or board is needed. Since the arm of the VersaWriter bends only in one direction, each point on the plotting head corresponds to a unique set of resistances on the potentiometers. All that's needed now is software to translate these resistances into usable screen coordinates.

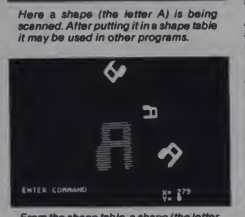
Exceptionally powerful software

It is in the software where VersaWriter really stands out. VersaWriter comes with two full disks of user-oriented software. First it has sets of "low level" commands for entering, creating and copying drawings and diagrams. Secondly, it has extensive sets of application routines for moving, enlarging, rotating, coloring or animating drawings that the user has created.

Of course the basic commands let you enter a drawing freehand or by tracing it. Want a wider "brush stroke"? Six widths are available. Drawings can be independently scaled in both the vertical and horizontal directions. An enclosed shape may be filled in with any of 212 colors. No, that is not a misprint—by the same technique that a printing press can create hundreds of colors from three primary ones, so can VersaWriter.



Here a shape (the letter A) is being scanned. After putting it in a shape table it may be used in other programs.



From the shape table, a shape (the letter A) may be enlarged, shrunk, rotated, colored or moved about the screen.

Create Animation for Other Programs

The shapes you create with VersaWriter can be used and manipulated with ease in other programs. Up to 255 shapes can be entered into a shape table. These shapes may then be placed on the screen in any position or may be overlaid on a full or partial screen image. Animation is produced easily by moving about a portion of the image created by VersaWriter. For example, by alternating between two images of an airplane propeller it will appear to be spinning.

Other VersaWriter software includes text-writer with which text can be added to graphics. Upper and lower case, choice of color, text size, direction and starting point all may be specified.

The Area/Distance program lets you calculate distances (or perimeters) by entering a scale and tracing a shape or map route with the drawing arm. Areas of figures, open and irregular, can be similarly calculated.

The software also includes sets of electronic and computer logic shapes. In addition, an entire disk of dramatic demonstration graphics is included. These twelve full-screen graphics run the gamut from a fully labeled cross section of a human skull to colored maps to animated cartoons to an electronics schematic.

Free Software Updates

You may have read a review of VersaWriter that indicated that the color fill routine was slow. It was. But not anymore. Several new routines and improvements were added to the VersaWriter software since its introduction. All customers of Peripherals Plus received these changes free.

As new updates are developed, Peripherals Plus will furnish them free to all customers FOREVER. We make this unique guarantee because it is in our best interest to have you make the best use of your computer. We're convinced that if other people see your VersaWriter in use, they'll want one too.

Best Performance and Price

At Peripherals Plus, we evaluated every graphics entry device. We wanted to handle the best one regardless of price. VersaWriter has the best performance bar none. Surprisingly it also has the lowest price, just $249.00 for the Apple version.

VersaWriter requires an Apple II with Applesoft in ROM (or an Apple II Plus), disk, and 48K of memory. The Atari version requires an Atari 800, disk and at least 32K. It is priced at $300.

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CIRCLE 239 ON READER SERVICE CARD

4.9 Restore READ statement to star data. Lines 3470-3520.
4.10 Restore READ statement to cargo data. Lines 3530-3580.
4.11 Restore READ statement to price data. Lines 3590-3640.
5. Data section. Lines 3650-4620.
5.1 Star names. Lines 3650-3750.
5.2 Cargo names. Lines 3770-4120.
5.3 Star data. Lines 4130-4230.
5.4 Cargo Data. Lines 4240-4600.
5.5 Price data. Lines 4610-4620.

The initialization section displays game instructions, initializes variables, seeds the random number function, and sets up the initial voyage from Alpha Centauri to Sol. (This initial voyage is necessary in the program logics since the statements that determine which cargos are for sale are contained in the travel to new starport subroutine.)

The main section is responsible for performing the following tasks:

1. Determining whether a strike is to occur.
2. Accepting a command and calling the appropriate subroutine.
3. Determining whether the player has run out of money.
4. Determining whether the ship's lease has expired.

Control is tranferred to the end section if the player runs out of money, if the lease on the ship expires and the player does not renew it, or if the lease expires and the player does not have enough money to renew it. If none of these conditions occur, control will be passed back to the beginning of the main section.

The end section prints out the end conditions of the game and transfers program control to the end statement.

The subroutine section contains subroutines which are called from both the initialization section and the main section. With the exception of subroutine 4.7 (travel to new starport), all subroutines are called by the line number listed at the beginning of the subroutine.

The ship time, player's account balance and available cargo space will be updated upon completion of the cargo transaction.

Upon entering the strike subroutine, the salary demands of the crew are calculated by adding from zero to fifty percent of their current salary to it. The minimum salary the crew will accept is then calculated from their current salary, their demanded salary, and the number of counter-offers which have previously been rejected. The minimum salary that the crew will accept will initially be equal to their current salary and will increase by ten percent of the difference between their salary demands and their current salary for each counter-offer that is rejected. The probability that a counter-offer will be accepted may be represented as a separate linear function for each number of counter-offers previously rejected. These functions are graphed in Figure 1.

The subroutines that list the cargos for sale and the cargos in the hold use the contents of arrays A and H respectively. A detailed description of these two arrays is included in the variable description. For each non-zero cargo type, the cargo name is obtained from the data section. This is done by doing a restore, followed by the required number of data reads necessary to position the data pointer to the cargo name that corresponds to the cargo. This cargo name along with other information in array A or H is then displayed with a PRINT USING statement. The PRINT USING statement and its corresponding IMAGE statement will require some modification in order for it to work with other Basics.

The subroutine for buying cargo consists of obtaining the lot number of the cargo to be purchased and transferring the corresponding data from the A array to the H array. The first empty position in the H array is used to store the cargo which has been purchased. The ship time, player's account balance, and available cargo space will be updated upon completion of the cargo transaction.

The subroutine for selling cargo consists of obtaining the partition number of the cargo to be sold, and sets the corresponding position in array H to zero. This is done to indicate that the partition is now empty. Ship time, player's account balance and available cargo will also be updated.

The list starport subroutine reads the starport name and trade class from the data section and displays them. Distance and direction for each starport will also be displayed, and stored in the arrays D and T respectively. The contents of these two arrays will have been previously calculated by the travel subroutine when it is executed.

The travel (to new starport) subroutine performs the following tasks:

1. Accept destination starport number and perform validity checks.
2. Get trade and location data for destination starport.
3. Appraise cargo stored in ship's hold.
4. Determine type, price and quantity of cargos available for purchase at destination starport.
5. Determine distance and direction of other starports from the destination starport.
6. Calculate and display arrival expenses and destination starport's name.

This subroutine is called each time the travel command is invoked, and also during program initialization. When this subroutine is called from the initialization section, the statements which accept the destination starport number are bypassed.

The three subroutines which are used to restore the READ statement to a particular data section basically do a restore followed by successive reads until the corresponding data section is reached.

The data section consists of the five types of data already mentioned. They are read as necessary. Each statement in the star-names section and the cargo-names section has a statement in the star-data section and the cargo-data section which corresponds to it.

The first two parameters in a data statement for star data are the X and Y coordinates of that star, relative to Sol. These values may be altered if you want to change the position of the star. The third parameter corresponds to the trade class of the starport. This value is calculated by representing each trade class by a power of two (listed in Table 1). An example of the calculation for generating the trade class is as follows: The trade class for Alpha Centauri is NA and 1. The parameter representing this trade class is thus $2^2 + 2^3$, which equals 9.

The data statements for cargo data consist of eight parameters. The first six parameters are used in calculating the price of the cargo. If the trade class of the starport corresponds to the parameter, the value of the parameter will be added to the random number which determines the price. The trade class to which each parameter corresponds is listed in Table 1.

THE PROGRAM STORE

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By Bill Budge from BudgeCo

If this program can't make the "Pinball Wizard" in you come alive, nothing can! With superb, HiRes color graphics and sound, this game offers all the fun and excitement of the real pinball machines without having to feed it quarters. Bumpers and traps abound. As you increase your skill, you will truly appreciate the action and full control built into the flippers: you can hit the ball, let it slide to just the right spot, even catch and hold it for positioning. Fun for everyone!

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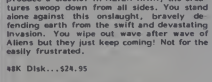
48K Disk...$24.95

REVERSAL



By Dan & Kathe Spracklen from Hayden

Based on the 200 year-old strategy game Reversi, this brilliant program won the software division of the First International Man Machine OTHELLO Tournament. You can learn to play in minutes, but mastering the strategy of this classic game may take a lifetime.

REVERSAL allows three playing strategies with nine levels of skill in each strategy. You can tell at a glance who is currently ahead by the expression on the playing pieces' faces, and if "asked" the computer will even kibitz with helpful hints on your play. Excellent use of color graphics and sound.

32K Disk...$34.95

Also by the Spracklens: SARGON II $34.95

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PULSAR II

By Nasir Gebelli from Sirius

Inspired by the popular "STAR CASTLE" arcade game, PULSAR II combines action, color, sound and challenge to provide a thoroughly enjoyable and absorbing game.

Choose from three modes of play. In the PULSAR option, your objective is to destroy the Pulsar by blasting holes in the fence like shields. The WORMWALL option challenges you to reach the center through a combination of permanent and momentary openings in the shield. In the COMBO mode, you alternate between the two options. The lower levels are fun for the beginner -- progressing to the higher levels requires skill and nerves of steel!

48K Disk...$29.95

AUTOBAHN

By Nasir Gebelli from Sirius

Take on the world's fastest highway in your Formula 7 racing car. Don't let the lush color graphics and realistic sound lull you into thinking you are out for a Sunday drive, because this road is out to getcha! Winding turns are the least of your troubles; you encounter other cars, trucks, dark tunnels and narrow bridges. Even the little puddles that sweep into view are a hazard at these speeds! The main object is to have fun and this program certainly provides it!

48K Disk...$29.95

the Prisoner™

By David Mullich from Edu-Ware

Venture to the nightmare of 1984 in this fantasy game inspired by the critically acclaimed TV series. Having tried to resign from "The Company," you have been drugged and removed to a prison island. The island's defenses have been designed to break down your reasoning powers and induce delusional thinking as it thwarts every attempt at escape. "They" want to know why you resigned, you want to escape; and it will take all your intelligence and sense of individuality to do so! "The Prisoner" provides a unique challenge that sets it apart from other adventure/fantasy games.

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DOGFIGHT

By Bill Basham from Micro Lab

Aerial action for the Apple. DOGFIGHT can be played against the computer, two players teamed against the computer, or two players on different teams. You can even set up your own game with the "Custom" mode.

Fly your plane around the screen in battle against the enemy. Your gun holds four bullets at a time and if you run out you will be a sitting duck while waiting to reload. If you shoot down the enemy, he may try to parachute to safety. Follow him down ... guns blazing ... because if he makes it, he will be back in another plane! Lots of action, graphics and sound.

48K Disk...$29.95

Crown of Arthain

By Dan & Marilyn Meller from Micro Lab

In the Mountain Kingdom of Arthain, the King lies dying. Though he has banished his two sons to the outer reaches, he now calls for their return, and the one who successfully completes the journey may take the crown.

This unusual adventure may be played against the computer or by two players simultaneously. Colorful HiRes graphics and 20 skill levels add to the fun as you magic and monsters along your way.

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3D GRAPHICS & GAME TOOL

By Bill Budge from Top of the Orchard

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Though useful to the expert, this program allows even novice programmers to create impressive animated graphics that move smoothly at frame speeds of 10-40 frames per second. A 52-page booklet shows you how to use it. Designs you produce with the program can be interfaced to either Integer or Applesoft BASIC, so you don't even need to know assembly language programming to benefit from this powerful tool. Order now -- this may well be your most used program!

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CIRCLE 175 ON READER SERVICE CARD

Star Merchant, continued...

Trade Class	Power of Two	Parameter
Rich	5	1
Poor	4	2
Industrial	3	3
Nonindustrial	2	4
Agricultural	1	5
Nonagricultural	0	6

Table 1.

A(5,4) Available cargo for purchase. First subscript references one of the five available cargos.
A(1,1) represents the cargo type of available cargo I. Value is set to zero when cargo I is purchased.
A(1,2) represents the price of cargo I.
A(1,3) represents the weight of cargo I in tons.
A(1,4) represents the price of cargo I as a percentage of its base price.

B1 Base price of a cargo. Value for B1 is read from the data statements.

B2 Amount of money in player's account.

B3 Player's total assets. Equal to B2+T1.

D(10) Distance in lightyears from player's present location to each of the ten starports. D(5) is initialized to 4.3 for initial journey from Alpha Centauri to Sol.

D2 Price modifier calculated from cargo trade modifiers and starport trade class.

D3 Cargo trade modifiers read from data statements.

D4 Distance to the destination starport.

D9 Dummy variable. Value is never used.

E1 Docking expense. Initial value is 5E4.

E2 Fuel expense for light year traveled. Value is 1E5.

E3 Annual salary of crew. Initial value is 5E5.

E4 Amount of crew's salary paid upon arriving at a starport.

E5 Salary demands of crew.

E6 Minimum counter-offer crew will accept during a salary strike.

E7 Amount of salary counter-offer.

G1 Average annual profit gain calculated at the end of the game.

H(20,4) Cargo stored in ship's hold. First subscript references the cargo hold partition number.
H(1,1) represents the cargo type in partition 1. Value is set to zero when partition is empty.
H(1,2) represents the price of the cargo in partition 1.
H(1,3) represents the weight of the cargo in partition 1.
H(1,4) represents the percentage of the base price the cargo in partition 1 has been appraised at.

I Temporary variable.

J Temporary variable.

K Temporary variable.

L Temporary variable.

M1 Trade class parameter of Starport.

M2 Variable used in unpacking trade class parameter.

N1 M1.

N2 Number of cargos available for purchase.

N3 Number of cargo types. Initialized to 36.

N4 Number of starports. Initialized to 10.

P(14) Number of counter-offers that have been rejected. Percentage values read from data statement. Used in modifying the base price of a cargo.

P2 Percentage index. Values may range from 1 to 14. Used to index P(14) to determine the percent of base price at which the cargo will trade.

Q1 Quantity index of a cargo type, as read from cargo data. Represents the number of times a random between 1 and 6 is used to generate the quantity.

Q2 Quantity multiplier. Random number used in generating cargo quantity is multiplied by Q2.
Q2 = 1 for cargo types 1 through 16.
Q2 = 5 for cargo types 17 through 31.
Q2 = 10 for cargo types 32 through 36.

Q3 Quantity of cargo in tons.

R1 Argument for random number function. Set equal to zero.

S(6) Array containing the trade class of the destination starport. Value is either 1 or 0.
S(1) = 1 implies starport is rich.
S(2) = 1 implies starport is poor.
S(3) = 1 implies starport is industrial.
S(4) = 1 implies starport is nonindustrial.
S(5) = 1 implies starport is agricultural.
S(6) = 1 implies starport is nonagricultural.

S1 Destination starport for starship. Initialized to 5.

T(10) Direction in degrees of all ten starports.

T1 Total value of cargo stored in the hold.

T2 Cargo type.

T5 The number of times the ship's two year lease is renewed.

T6 Elapsed ship time in years.

T7 Ship time when crew was paid.

W1 Total cargo capacity of ship. Set to 200.

W2 Amount of empty cargo space on ship. Initially set equal to W1 to indicate an empty cargo hold.

X1 Starport's X coordinate relative to Sol.

X2 Starport's X coordinate relative to present position of ship.

X3 X coordinate of destination star relative to Sol.

Y1 Y coordinate of starport relative to Sol.

Y2 Y coordinate of starport relative to ship's present position.

Y3 Y coordinate of destination star relative to Sol.

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CIRCLE 104 ON READER SERVICE CARD

Star Merchant Sample Run

```
                    STAR MERCHANT
YOU HAVE JUST SPENT 2 MILLION CREDITS ON A 2 YEAR
LEASE FOR A MERCHANT STARSHIP.  THIS LEAVES YOU WITH
2 MILLION CREDITS OPERATING CAPITAL.

YOUR SHIP CAN HOLD A TOTAL OF 20 CARGOS WITH A TOTAL
CARGO WEIGHT OF 200 TONS.  THE FUEL CAPACITY OF YOUR
SHIP IS GREAT ENOUGH SUCH THAT TRAVEL BETWEEN ANY
TWO STARPORTS IS POSSIBLE WITHOUT REFUELING.

YOU ARE PRESENTLY TRAVELING FROM ALPHA CENTAURI TO SOL.
YOU ARE CARRYING NO CARGO.

THE STARPORT TRADE CLASSIFICATION DETERMINES THE CARGO
PRICE BUT DOES NOT DETERMINE WHICH CARGOS ARE AVAILABLE.

ABBREVIATIONS USED FOR TRADE CLASS ARE AS FOLLOWS:
R-RICH,P-POOR,I-INDUSTRIAL,NI-NONINDUSTRIAL,
A-AGRICULTURAL,NA-NONAGRICULTURAL

PRESS RETURN TO CONTINUE?109
COMMANDS AVAILABLE ARE AS FOLLOWS:
     COMMAND                DESCRIPTION
        1                   LIST CARGO IN HOLD
        2                   LIST CARGO WHICH MAY BE PURCHASED
        3                   BUY CARGO
        4                   SELL CARGO
        5                   LIST STARPORTS
        6                   TRAVEL TO NEW STAR
      OTHER                 LIST AVAILABLE COMMANDS

INPUT A RANDOM NUMBER BETWEEN 1 AND 500?109


YOU HAVE ARRIVED AT SOL
EXPENSES HAVE BEEN DEDUCTED AS FOLLOWS:
DOCKING FEE 50000.
FUEL 830000.
CREW SALARY 53000.

ACCOUNT BALANCE 1.86700E+06     EMPTY CARGO SPACE 200
941P TIME .106          YEARS.    ENTER COMMAND?2

CARGOS AVAILABLE FOR PURCHASE
CARGO NUM      DESCRIPTION          AMT     PRICE    % OF BASE
    1          LIQUOR               25      375000     150
    2          RADIOACTIVES          6     5400000      90
    3          GRAV SLEDS            8    31200000     130
    4          ELECTRONIC PARTS      5      750000     150
    5          POLYMERS             40      196000      70

ACCOUNT BALANCE 1.86700E+06     EMPTY CARGO SPACE 200
941P TIME .106          YEARS.    ENTER COMMAND?3

ENTER THE LOT NUMBER OF CARGO YOU WISH TO PURCHASE?5
TRANSACTION COMPLETED
CARGO STORED IN PARTITION 1

ACCOUNT BALANCE 1.27100E+06     EMPTY CARGO SPACE 160
941P TIME .109          YEARS.    ENTER COMMAND?5


STAR NUM          NAME          TRADE CLASS  DISTANCE DIRECTION
    1          LALANDE 21185       NI,P          7.80       291
    2          ALPHA CENTAURI      NA,I          4.20       236
    3          SIRIUS              A             12.99        50
    4          BARNARDS STAR       I,P            6.10       180
    5          SOL                 R              0.00        90
    6          ROSS 154            NI,NA          9.10       167
    7          EPSILON ERIDANI     A,P           10.75        30
    8          LUYTEN 724-8        NA            8.00        68
    9          LUYTEN 789-6        A,NI,P        10.30       115
   10          ROSS 248            A,I           10.30        95

ACCOUNT BALANCE 1.27100E+06     EMPTY CARGO SPACE 160
941P TIME .109          YEARS.    ENTER COMMAND?6

ENTER DESTINATION STAR NUMBER?2

YOU HAVE ARRIVED AT ALPHA CENTAURI
EXPENSES HAVE BEEN DEDUCTED AS FOLLOWS:
DOCKING FEE 50000.
FUEL 429344.
CREW SALARY 54834.4

ACCOUNT BALANCE 737222.     EMPTY CARGO SPACE 160
941P TIME .214849       YEARS.    ENTER COMMAND?1
```

```
CARGO STORED IN HOLD
PARTITION       DESCRIPTION        AMT      PRICE     % OF BASE
   1            POLYMERS           40       476000    170

ACCOUNT BALANCE 737222.        EMPTY CARGO SPACE 160
SHIP TIME .214869      YEARS.      ENTER COMMAND?4

ENTER PARTITION OF CARGO TO BE SOLD?1
TRANSACTION COMPLETED

THE CREW HAS GONE ON STRIKE
YOU ARE CURRENTLY PAYING THEM 500000.      CREDITS ANNUALLY
THEY ARE ASKING FOR 747858.      CREDITS ANNUAL SALARY

ENTER COUNTER OFFER?660000.
OFFER ACCEPTED

ACCOUNT BALANCE 1.21322E+06      EMPTY CARGO SPACE 200
SHIP TIME .217869      YEARS.      ENTER COMMAND?2

CARGOS AVAILABLE FOR PURCHASE
CARGO NUM       DESCRIPTION        AMT      PRICE     % OF BASE
     1          GRAIN              100      51000     170
     2          COMPUTER PARTS     20       2100000   70
     3          GRAIN              165      198000    400
     4          GRAV SLEDS         5        32999995  110
     5          AIRCRAFT           5        2000000   40

ACCOUNT BALANCE 1.21322E+06      EMPTY CARGO SPACE 200
SHIP TIME .217869      YEARS.      ENTER COMMAND?3

ENTER THE LOT NUMBER OF CARGO YOU WISH TO PURCHASE?1
TRANSACTION COMPLETED

CARGO STORED IN PARTITION 1

ACCOUNT BALANCE 1.16222E+06      EMPTY CARGO SPACE 100
SHIP TIME .220869      YEARS.      ENTER COMMAND?5

STAR NUM        NAME               TRADE CLASS   DISTANCE   DIRECTION
     1          LALANDE 21185      NI,P          4.45       324
     2          ALPHA CENTAURI     NA,I          0.00       90
     3          SIRUS              A             17.27      51
     4          AARNARDS STAR      I,P           5.13       136
     5          SOL                M             4.29       56
     6          2083 154           NI,NA         8.56       139
     7          EPSILON ERIDANI    A,P           14.90      43
     8          LUYTEN 726-8       NA            12.23      64
     9          LUYTEN 789-6       A,NI,P        13.02      99
    10          2083 248           A,I           13.90      44

ACCOUNT BALANCE 1.16222E+06      EMPTY CARGO SPACE 100
SHIP TIME .220869      YEARS.      ENTER COMMAND?6

ENTER DESTINATION STAR NUMBER?4

YOU HAVE ARRIVED AT BARNARDS STAR
EXPENSES HAVE BEEN DEDUCTED AS FOLLOWS:
DOCKING FEE 50000.
FUEL 513455.
CREW SALARY 84936.

ACCOUNT BALANCE 513831.      EMPTY CARGO SPACE 100
SHIP TIME .34356       YEARS.      ENTER COMMAND?1

CARGO STORED IN HOLD
PARTITION       DESCRIPTION        AMT      PRICE     % OF BASE
   1            GRAIN              100      36000     120

ACCOUNT BALANCE 513831.      EMPTY CARGO SPACE 100
SHIP TIME .34356       YEARS.      ENTER COMMAND?2

CARGOS AVAILABLE FOR PURCHASE
CARGO NUM       DESCRIPTION        AMT      PRICE     % OF BASE
     1          ADDY ARMOR         6        300000    100
     2          CRYSTALS           1        10000     50
     3          MECHANICAL PARTS   20       1050000   70
     4          GRAV SLEDS         3        14400000  80
     5          CYBERNETIC PARTS   15       1500000   40

ACCOUNT BALANCE 513831.      EMPTY CARGO SPACE 100
SHIP TIME .34356       YEARS.      ENTER COMMAND?3

ENTER THE LOT NUMBER OF CARGO YOU WISH TO PURCHASE?2
TRANSACTION COMPLETED
CARGO STORED IN PARTITION 2

ACCOUNT BALANCE 503831.      EMPTY CARGO SPACE 99
SHIP TIME .34656       YEARS.      ENTER COMMAND?3

ENTER THE LOT NUMBER OF CARGO YOU WISH TO PURCHASE?1
TRANSACTION COMPLETED
CARGO STORED IN PARTITION 3
```


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CIRCLE 169 ON READER SERVICE CARD

Star Merchant Program Listing

```
10  REM
20  REM STAR MERCHANT
30  REM BY LLOYD JOHNSON
40  REM
50  REM INITIALIZE SECTION
60  DIM A$(20),B$(8),A(5,4),D(10),M(20,4)
70  DIM P(14),S(6),T(10)
80  PRINT TAB(20)"STAR MERCHANT"
90  PRINT "YOU HAVE JUST SPENT 2 MILLION CREDITS ON A 2 YEAR"
100 PRINT "LEASE FOR A MERCHANT STARSHIP.  THIS LEAVES YOU WITH"
110 PRINT "2 MILLION CREDITS OPERATING CAPITAL."
120 PRINT
130 PRINT "YOUR SHIP CAN HOLD A TOTAL OF 20 CARGOS WITH A TOTAL"
140 PRINT "CARGO WEIGHT OF 200 TONS.  THE FUEL CAPACITY OF YOUR"
150 PRINT "SHIP IS GREAT ENOUGH SUCH THAT TRAVEL BETWEEN ANY"
160 PRINT "TWO STARPORTS IS POSSIBLE WITHOUT REFUELING."
170 PRINT
180 PRINT "YOU ARE PRESENTLY TRAVELING FROM ALPHA CENTAURI TO SOL."
190 PRINT "YOU ARE CARRYING NO CARGO."
200 PRINT
210 PRINT "THE STARPORT TRADE CLASSIFICATION DETERMINES THE CARGO"
220 PRINT "PRICE BUT DOES NOT DETERMINE WHICH CARGOS ARE AVAILABLE."
230 PRINT
240 PRINT "ABBREVIATIONS USED FOR TRADE CLASS ARE AS FOLLOWS:"
250 PRINT "R=RICH,P=POOR,I=INDUSTRIAL,NI=NONINDUSTRIAL,"
260 PRINT "A=AGRICULTURAL,NA=NONAGRICULTURAL"
270 PRINT
280 PRINT "PRESS RETURN TO CONTINUE";
290 INPUT A$
300 PRINT "COMMANDS AVAILABLE ARE AS FOLLOWS:"
310 GOSUB 3380
320 LET R1=0
330 PRINT
340 PRINT "INPUT A RANDOM NUMBER BETWEEN 1 AND 500";
350 INPUT I
360 PRINT
370   FOR J=1 TO I
380   LET D9=RND(R1)
390   NEXT J
400 DEF FNA(R1)=INT(6*RND(R1))+1
410 DEF FNB(N2)=INT(N2*RND(R1))+1
420 DEF FNC(R1)=FNA(R1)+FNA(R1)
430 LET B2=2.00000E+06
440 LET O(5)=.3
450 LET S1=5
460 LET E1=50000.
470 LET E2=100000.
480 LET E3=500000.
490 LET N2=36
500 LET N3=10
510 LET W1=200
520 LET W2=W1
530   FOR I=1 TO 20
540   LET M(I,11)=0
550   NEXT I
560 GOSUB 3590
570   FOR I=1 TO 14
580   READ P(I)
590   NEXT I
600 LET T5=0
610 LET T6=0
620 LET T7=0
630 GOSUB 2280
640 REM MAIN LOGIC
650 IF RND(R1)>.01+.005*A2/E3 THEN 670
660 GOSUB 1040
670 PRINT
680 PRINT "ACCOUNT BALANCE ";B2;"EMPTY CARGO SPACE ";W2
690 PRINT "SHIP TIME ";T6;"YEARS.    ENTER COMMAND";
700 INPUT C1
710 PRINT
720 IF C1>0 AND C1<7 AND C1=INT(ABS(C1)) THEN 750
730 GOSUB 3380
740 GOTO 640
750 GOSUB C1 OF 1240,1420,1590,1900,2050,2150
760 LET B3=B2+T1
770 IF B3<0 THEN 890
780 IF T6=2+T5*2 THEN 840
790 PRINT
800 PRINT "THE LEASE HAS EXPIRED ON YOUR SHIP"
```

```
410  IF B3<2.00000E+06 THEN 890
420  PRINT "ANOTHER TWO YEAR LEASE WILL COST 2E6 CREDITS"
430  PRINT "DO YOU WISH TO RENEW YOUR LEASE(Y/N)";
440  INPUT A$
450  IF A$="N" THEN 890
460  LET B2=B2-2.00000E+06
470  LET T5=T5+1
480  GOTO 640
490  REM END PROGRAM
900  LET G1=(B3-4.00000E+06)/T6
910  LET A$="LOSS"
920  IF G1<0 THEN 940
930  LET A$="GAIN"
940  IF B3>0 THEN 970
950  PRINT
960  PRINT "YOU NO LONGER HAVE SUFFICIENT FUNDS TO OPERATE YOUR SHIP"
970  PRINT
980  PRINT "YOU STARTED WITH 4E6 CREDITS"
990  PRINT "YOU NOW HAVE ";B2
1000 PRINT "CARGO IN HOLD IS WORTH ";T1
1010 PRINT
1020 PRINT "THIS REPRESENTS A ";A$;" OF ";G1;"CREDITS PER YEAR"
1030 GOTO 4630
1040 REM STRIKE SUB
1050 PRINT
1060 PRINT "THE CREW HAS GONE ON STRIKE"
1070 PRINT "YOU ARE CURRENTLY PAYING THEM ";E3;"CREDITS ANNUALLY"
1080 LET E5=E3+.5*RND(R1)*E3
1090 PRINT "THEY ARE ASKING FOR ";E5;"CREDITS ANNUAL SALARY"
1100 LET N4=0
1110 LET E6=E3+N4*(E5-E3)/10
1120 PRINT
1130 PRINT "ENTER COUNTER OFFER";
1140 INPUT E7
1150 IF E7 >= E5 THEN 1210
1160 IF E7<E6 THEN 1180
1170 IF (E5+E7)/(E5-E6)<RND(R1) THEN 1210
1180 PRINT "OFFER REJECTED - TRY AGAIN"
1190 LET N4=N4+1
1200 GOTO 1110
1210 PRINT "OFFER ACCEPTED"
1220 LET E3=E7
1230 RETURN
1240 REM LIST HOLD
1250 PRINT "CARGO STORED IN HOLD"
1260 IF A2<=1 THEN 1290
1270 PRINT "ALL PARTITIONS ARE EMPTY"
1280 RETURN
1290 PRINT "PARTITION      DESCRIPTION      AMT";
1300 PRINT "      PRICE    % OF BASE"
1310   FOR I=1 TO 20
1320   RESTORE
1330   IF M(I,1)=0 THEN 1400
1340     FOR J=1 TO 19*M(I,1)
1350     READ A$
1360     NEXT J
1370   READ A$
1380   PRINT USING 1390;I,A$,M(I,3),M(I,2),M(I,4)
1390   IMAGE 3X,2D,5X,18A,2X,3D,2X,4D,4X,3D
1400   NEXT I
1410 RETURN
1420 REM LIST CARGO FOR SALE
1430 PRINT "CARGOS AVAILABLE FOR PURCHASE"
1440 IF N1>0 THEN 1470
1450 PRINT "ALL AVAILABLE CARGOS HAVE BEEN PURCHASED"
1460 RETURN
1470 PRINT "CARGO NUM      DESCRIPTION      AMT";
1480 PRINT "      PRICE    % OF BASE"
1490   FOR I=1 TO 5
1500   RESTORE
1510   IF A(I,1)=0 THEN 1570
1520     FOR J=1 TO 19*A(I,1)
1530     READ A$
1540     NEXT J
1550   READ A$
1560   PRINT USING 1390;I,A$,A(I,3),A(I,2),A(I,4)
1570   NEXT I
1580 RETURN
1590 REM BUY CARGO SUB
1600 PRINT "ENTER THE LOT NUMBER OF CARGO YOU WISH TO PURCHASE";
1610 INPUT K
1620 IF K=ABS(INT(K)) AND K>0 AND K<6 THEN 1650
1630 PRINT "INVALID LOT NUMBER"
1640 RETURN
1650 IF A(K,1)>0 THEN 1680
1660 PRINT "LOT ";K;"HAS BEEN ALREADY PURCHASED"
1670 RETURN
1680 IF A(K,2) <= B2 THEN 1710
```


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CIRCLE 202 ON READER SERVICE CARD

Star Merchant, continued...

```
1690 PRINT "YOU CANNOT BUY CARGO ON CREDIT"
1700 RETURN
1710 IF A(K,3) <= M2 THEN 1740
1720 PRINT "YOU DO NOT HAVE SUFFICIENT CARGO SPACE"
1730 RETURN
1740   FOR I=1 TO 20
1750     IF H(I,1)=0 THEN 1790
1760     NEXT I
1770 PRINT "ALL 20 CARGO PARTITIONS ARE OCCUPIED"
1780 RETURN
1790   FOR J=1 TO 6
1800     LET H(I,J)=A(K,J)
1810     NEXT J
1820 LET A(K,1)=0
1830 LET M2=M2-M(I,3)
1840 LET B2=B2-M(I,2)
1850 LET T6=T6+.003
1860 LET N1=N1-1
1870 PRINT "TRANSACTION COMPLETED"
1880 PRINT "CARGO STORED IN PARTITION ";I
1890 RETURN
1900 REM SELL CARGO SUB
1910 PRINT "ENTER PARTITION OF CARGO TO BE SOLD";
1920 INPUT K
1930 IF K=ABS(INT(K)) AND K>0 AND K<21 THEN 1940
1940 PRINT "INVALID PARTITION NUMBER"
1950 RETURN
1960 IF H(K,1)>0 THEN 1990
1970 PRINT "CARGO PARTITION IS EMPTY"
1980 RETURN
1990 LET M2=M2+H(K,2)
2000 LET M2=M2+H(K,3)
2010 LET T6=T6+.003
2020 LET H(K,1)=0
2030 PRINT "TRANSACTION COMPLETED"
2040 RETURN
2050 REM LIST STARPORTS SUB
2060 PRINT "STAR NUM              NAME                TRADE CLASS";
2070 PRINT "  DISTANCE DIRECTION"
2080 RESTORE
2090   FOR I=1 TO 10
2100   READ A$,B$
2110   PRINT  USING 2120;I,A$,B$,D(I),T(I)
2120   IMAGE 3X,2D,4X,20A,2X,10A,3D.2D,4X,3D
2130   NEXT I
2140 RETURN
2150 REM TRAVEL SUB
2160 IF M2>0 THEN 2190
2170 PRINT "YOU CANNOT LEAVE STARPORT
           UNTIL ALL DEBTS ARE CLEARED"
2180 RETURN
2190 PRINT "ENTER DESTINATION STAR NUMBER";
2200 INPUT I
2210 IF I<31 THEN 2240
2220 PRINT "YOU ARE ALREADY AT ";I
2230 RETURN
2240 IF I<>ABS(INT(I)) AND I>0 AND I<N3+1 THEN 2270
2250 PRINT "INVALID STAR NUMBER"
2260 RETURN
2270 LET S1=I
2280 REM GET STAR TRADE & LOCATION DATA
2290 GOSUB 3470
2300 IF S1=1 THEN 2340
2310   FOR I=1 TO (S1-1)*3
2320   READ D9
2330   NEXT I
2340 READ X3,Y3,M1
2350   FOR I=1 TO 6
2360   LET M2=2^(6-I)
2370   LET S(I)=(INT(M1/M2)
2380   LET M1=M1-S(I)*M2
2390   NEXT (
2400 REM APPRAISE CARGO IN HOLD
2410 LET T1=0
2420   FOR I=1 TO 20
2430   IF H(I,1)=0 THEN 2630
2440   GOSUB 3530
2450   IF H(I,1)=1 THEN 2490
2460     FOR J=1 TO (H(I,1)-1)*8
2470     READ D9
2480     NEXT J
2490   LET D2=0
2500     FOR J=1 TO 6
2510     READ D3
2520     LET D2=D2+D3*S(J)
2530     NEXT J
2540   READ B1
2550   LET P2=FNC(B1)*D2+1
2560   IF P2>1 THEN 2580
```

```
2570    LET P2=1
2580    IF P2=16 THEN 2600
2590    LET P2=16
2600    LET M(I,4)=P(P2)*100
2610    LET M(I,2)=P(P2)*81*M(I,3)
2620    LET T1=T1+M(I,2)
2630    NEXT I
2640  REM GET CARGOS FOR SALE
2650  LET N1=5
2660    FOR I=1 TO 5
2670    LET O2=0
2680    LET T2=FNR(N2)
2690    LET A(I,1)=T2
2700    GOSUB 3530
2710    IF T2=1 THEN 2750
2720      FOR J=1 TO (T2-1)*8
2730      READ O9
2740      NEXT J
2750      FOR J=1 TO 6
2760      READ O3
2770      LET O2=O2+O3*S(J)
2780      NEXT J
2790    LET P2=FNC(R1)+O2-1
2800    IF P2>1 THEN 2820
2810    LET P2=1
2820    IF P2<14 THEN 2840
2830    LET P2=14
2840    LET A(I,4)=P(P2)*100
2850    READ R1,Q1
2860    LET Q2=1
2870    IF T2<17 THEN 2910
2880    LET Q2=5
2890    IF T2<32 THEN 2910
2900    LET Q2=10
2910    LET Q3=0
2920      FOR J=1 TO Q1
2930      LET Q3=FNA(R1)+O2+O3
2940      NEXT J
2950    LET A(I,3)=O3
2960    LET A(I,2)=R1+O3*P(P2)
2970    NEXT I
2980  REM DISTANCE AND DIRECTION OF STARS
2990  LET D4=D(S1)
3000  GOSUB 3470
3010    FOR I=1 TO 10
3020    READ X1,Y1,O9
3030    LET X2=X1-X3
3040    LET Y2=Y1-Y3
3050    IF X2=0 THEN 3110
3060    IF Y2<0 THEN 3090
3070    LET T(I)=90
3080    GOTO 3180
3090    LET T(I)=270
3100    GOTO 3180
3110    LET T(I)=ATN(Y2/X2)*180/3.14159
3120    IF X2>0 THEN 3140
3130    LET T(I)=T(I)+180
3140    IF T(I)<360 THEN 3160
3150    LET T(I)=T(I)-360
3160    IF T(I)>0 THEN 3180
3170    LET T(I)=T(I)+360
3180    LET D(I)=SQR(X2^2+Y2^2)
3190    NEXT I
3200  REM ARRIVAL EXPENSES AND STAR NAME
3210  LET T6=T6+.02*D4+.02
3220  LET E4=(T6+T7)*E3
3230  LET T7=T6
3240  RESTORE
3250  IF S1=1 THEN 3290
3260    FOR I=1 TO S1-1
3270    READ A$,A$
3280    NEXT I
3290  READ A$,B$
3300  PRINT
3310  PRINT "YOU HAVE ARRIVED AT ";A$
3320  PRINT "EXPENSES HAVE BEEN DEDUCTED AS FOLLOWS:"
3330  PRINT "DOCKING FEE ";E1
3340  PRINT "FUEL ";E2*D4
3350  PRINT "CREW SALARY ";E4
3360  LET O2=R2-(E1+E2*D4+E4)
3370  RETURN
3380  PRINT TAB(5);"COMMAND";TAB(25);"DESCRIPTION"
3390  PRINT TAB(8);"1";TAB(25);"LIST CARGO IN HOLD"
3400  PRINT TAB(8);"2";TAB(25);"LIST CARGO WHICH
                               MAY BE PURCHASED"
3410  PRINT TAB(8);"3";TAB(25);"BUY CARGO"
3420  PRINT TAB(8);"4";TAB(25);"SELL CARGO"
3430  PRINT TAB(8);"5";TAB(25);"LIST STARPORTS"
3440  PRINT TAB(8);"6";TAB(25);"TRAVEL TO NEW STAR"
```

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Star Merchant, continued...

```
1450  PRINT TAB(6);"OTHER";TAB(25);"LIST AVAILABLE COMMANDS"
1460  RETURN
1470  REM RESTORE TO STAR DATA SUB
1480  RESTORE
1490    FOR L=1 TO (2*N3+N2)
1500    READ A$
1510    NEXT L
1520  RETURN
1530  REM RESTORE TO CARGO DATA SUB
1540  GOSUB 3470
1550    FOR L=1 TO 3*N3
1560    READ D9
1570    NEXT L
1580  RETURN
1590  REM RESTORE TO PRICE DATA SUB
1600  GOSUB 3530
1610    FOR L=1 TO 8*N2
1620    READ D9
1630    NEXT L
1640  RETURN
1650  REM STAR NAMES
1660  DATA "LALANDE 21185","NI,P"
1670  DATA "ALPHA CENTAURI","NA,I"
1680  DATA "SIRUS","A"
1690  DATA "BARNARDS STAR","1,P"
1700  DATA "SOL","R"
1710  DATA "ROSS 154","NI,NA"
1720  DATA "EPSILON ERIDANI","A,P"
1730  DATA "LUYTEN 726-8","NA"
1740  DATA "LUYTEN 789-6","A,NI,P"
1750  DATA "ROSS 248","A,I"
1760  REM CARGO NAMES
1770  DATA "CRYSTALS"
1780  DATA "RADIOACTIVES"
1790  DATA "SPECIAL ALLOYS"
1800  DATA "PHARMACEUTICALS"
1810  DATA "GEMS"
1820  DATA "AIRCRAFT"
1830  DATA "GRAV SLEDS"
1840  DATA "COMPUTERS"
1850  DATA "ATV"
1860  DATA "AFV"
1870  DATA "FIREARMS"
1880  DATA "AMMUNITION"
1890  DATA "PLASMA GUNS"
1900  DATA "TOOLS"
1910  DATA "BODY ARMOR"
1920  DATA "FARM MACHINERY"
1930  DATA "LIQUOR"
1940  DATA "SILVER"
1950  DATA "SPICES"
1960  DATA "ELECTRONIC PARTS"
1970  DATA "MECHANICAL PARTS"
1980  DATA "CYBERNETIC PARTS"
1990  DATA "COMPUTER PARTS"
4000  DATA "MACHINE TOOLS"
4010  DATA "SPACE SUITS"
4020  DATA "FRUIT"
4030  DATA "TEXTILES"
4040  DATA "POLYMERS"
4050  DATA "MEAT"
4060  DATA "PETROCHEMICALS"
4070  DATA "GRAIN"
4080  DATA "WOOD"
4090  DATA "COPPER"
4100  DATA "TIN"
4110  DATA "STEEL"
4120  DATA "ALUMINUM"
4130  REM STAR DATA
4140  DATA 2,A3,-7,36,20
4150  DATA -2,4,-3,56,9
4160  DATA 8,3A,9,93,2
4170  DATA -6,1,0,24
4180  DATA 0,0,32
4190  DATA -A,87,2,05,5
4200  DATA 8,45,6,65,18
4210  DATA 2,99,7,42,1
4220  DATA -4,83,9,3,22
4230  DATA -9,10,28,10
4240  REM CARGO DATA
4250  DATA 3,-2,2,-2,0,-4,20000,1
4260  DATA 0,1,-4,3,0,-2,1,00000E+06,1
4270  DATA -2,0,-4,6,1,-2,200000,,1
4280  DATA -1,4,-4,3,-2,0,100000,,1
4290  DATA 4,-2,4,-6,-1,1,1,00000E+06,1
4300  DATA -2,6,-3,3,1,-1,00000E+06,1
4310  DATA 2,0,-1,1,0,0,6,00000E+06,1
4320  DATA 1,0,-2,0,0,0,1,00000E+07,1
4330  DATA -2,2,-2,1,1,0,300000,,1
4340  DATA 0,2,-2,0,0,1,700000,,1
4350  DATA -2,6,-4,1,0,0,30000,2
4360  DATA -1,6,-5,2,0,0,30000,2
4370  DATA -1,3,-2,0,0,0,200000,,2
4380  DATA -4,7,-4,5,0,1000,2
4390  DATA -3,6,-4,1,0,0,50000,,2
4400  DATA -2,2,-6,0,6,-4,150000,,1
4410  DATA 3,3,-1,0,-3,0,10000,1
4420  DATA 3,-1,3,-1,0,-2,70000,,1
4430  DATA 4,-2,3,-1,-5,2,6000,1
4440  DATA 0,0,-4,4,1,1,100000,,1
4450  DATA 0,1,-3,3,2,1,75000,,1
4460  DATA 1,0,-4,5,2,1,50000,,1
4470  DATA -1,0,-2,3,0,0,150000,,1
4480  DATA 1,0,-2,1,0,0,750000,,1
4490  DATA -1,2,-1,2,2,0,40000,,1
4500  DATA 1,2,3,3,-4,-6,1000,2
4510  DATA 3,0,-3,1,-5,-3,3000,3
4520  DATA -2,0,3,3,0,0,7000,4
4530  DATA 0,0,5,2,-5,5,1500,4
4540  DATA 2,0,4,-2,1,0,10000,6
4550  DATA 0,0,1,3,-5,6,300,8
4560  DATA 0,0,1,2,-7,1,1000,2
4570  DATA 2,2,3,-2,-1,-4,2000,2
4580  DATA 2,2,3,-4,-1,-2,9000,3
4590  DATA -1,2,6,0,0,0,500,4
4600  DATA -1,1,3,-2,0,-2,1000,5
4610  REM PRICE DATA
4620  DATA .4,.5,.7,.8,.9,1.1.1,
      1.2,1.3,1.5,1.7,2,3,4
4630  END
```

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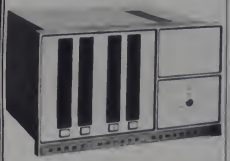

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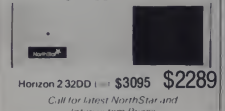

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Nuclear power plants are going to be with us for a long time, presenting challenges to their supporters and to their opponents. Many people have opinions about nuclear plants, but not many have a clear idea how they work.

A written description of something as complex as a nuclear power plant has a tendency to overwhelm people with layers of detail. There is no way to write a description of the interactions between the rate of heat generation in the reactor core, the rate of flow of primary and secondary coolants, the electrical power output of the turbine-generator, and the temperatures of the various components, and at the same time have a readable, comprehensible, reasonably accurate presentation which is interesting enough for most people to wade through. Here is an opportunity for microcomputers to show their stuff.

Simulation is a field in which microcomputers can make a major contribution toward a better-informed population. Computers certainly have a bright future in such applications as information retrieval and record-keeping, but their educational potential has not even begun to be developed, especially in the public schools. The ability of a computer to simulate a complex and fluid situation, and to involve a person directly in that situation, cannot be duplicated or even approximated by books, films, television, or by a human teacher—no matter how gifted.

For these reasons I was glad to find Stephen R. Berggren's nuclear power plant simulation program in the December 1980 issue of *Creative Computing*. This is a fine example of the sort of simulation which develops the unique educational capabilities of microcomputers. It tackles a topic which is vitally important to today's society, a topic which has been almost totally ignored in the public schools. Sure, the schools talk about radiation hazards from an environmental point of view, an important subject, but how many of this year's high school graduates will have even a foggy notion of how a nuclear power station *works*? For that matter, how many teachers—even science teachers—know?

Berggren's simulation makes it easy, even entertaining, to find out the basics of the inner workings of the heat cycle of a nuclear power plant.

The school in which I work has PET computers. Berggren's program is written for the Apple, so I undertook to adapt it for the PET. I found it took more effort to make this adaptation than I expected. Here is the result, so that this valuable simulation will be available to many who might want to use it, but do not have an Apple.

To maintain as much comparability as possible between this PET version and the original Apple version, the statements have not been renumbered, despite a certain higgledy-piggledy quality which has evolved. I have not tampered with the core of Berggren's program, the equations which describe the heat transfer characteristics of the plant, because they work very well as they are, and because I do not understand them well enough to attempt any changes.

The graphics, which begin at statement 6000, have been completely rewritten by my son, Hume Smith. Berggren's commentary on variables, which begins at statement 9000, is reproduced in Figure 1. His variables have been retained without change except as noted below.

New variables VE and VE$, statements 762-766, have been introduced to repre-

Figure 1.

```
9000  REM VARIABLE PREFIXES
9010  REM A-CONTROL RODS, C-COOLING TOWER, E-EMERGENCY COOLANT,
      G-TURBINE, P-PRIMARY COOLANT, R-REACTOR, S-SECONDARY COOLANT,
      X-HEAT EXCHANGER
9020  REM VARIABLE SUFFIXES
9030  REM B-BROKEN, D-DAMAGE, F-FLOW RATE, H-HEAT FLOW, L-LIFE, O-OUTPUT,
      T-TEMPERATURE, V-VOLUME
9040  REM OTHER VARIABLES TOT-TOTAL POWER OUTPUT, KW-AVERAGE POWER
      OUTPUT, DAY-DAY OF OPERATION, DMGE-TOTAL EQUIPMENT DAMAGE
9050  REM PROGRAM DISCRIPTION BY LINE NUMBER
9060  REM 10-220 INTRODUCTION
9070  REM 225-380 INSTRUCTIONS
9080  REM 390-455 VARIABLE INITIATION
9090  REM  460-850 WRITE REPORT AND ASSESS DAMAGE
9100  REM  900-1165 INPUT NEW CONTROL VARIABLES
9110  REM 1170 MAINTENANCE SHUTDOWN EVALUATION
9120  REM 1200-1260 PUMP FAILURE ASSESSMENT
9130  REM 1270-1430 PLANT OPERATING ALGORITHMS
9140  REM 2000-2200 MAINTENANCE SHUTDOWN SUBROUTINE
9150  REM 3000-3190 MELTDOWN ENDING
9160  REM 4000-4290 EVALUATION OF GAME RESULTS
9170  REM 5000-5070 END
9180  REM 6000-7960 PLANT DIAGRAM SUBROUTINE
9190  REM 9000-9190 REMARKS
9200  REM  APPLE NUCLEAR POWER PLANT
9210  REM  BY STEPHEN R BERGGREN
```

Ivan C. Smith, P.O. Box 226, Chester, N.S., Canada B0J 1J0.

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The image on the screen was created by the program below.

```
 10 VISMEM: CLEAR
 20 P=160: Q=100
 30 XP=144: XR=1.5*3.1415927
 40 YP=56: YR=1: ZP=64
 50 XF=XR/XP: YF=YP/YR: ZF=XR/ZP
 60 FOR ZI=-Q TO Q-1
 70 IF ZI<-ZP OR ZI>ZP GOTO 150
 80 ZT=ZI*XP/ZP: ZZ=ZI
 90 XL=INT(.5+SQR(XP*XP-ZT*ZT))
100 FOR XI=-XL TO XL
110 XT=SQR(XI*XI+ZT*ZT)*XF: XX=XI
120 YY=(SIN(XT)+.4*SIN(3*XT))*YF
130 GOSUB 170
140 NEXT XI
150 NEXT ZI
160 STOP
170 X1=XX+ZZ+P
180 Y1=YY-ZZ+Q
190 GMODE 1: MOVE X1,Y1: WRPIX
200 IF Y1=0 GOTO 220
210 GMODE 2: LINE X1,Y1-1,X1,0
220 RETURN
```

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sent the dollar value of the energy produced. This has been calculated at 5.5¢ per kWh, a value which can be changed in statement 762. VE$ is used to convert a number greater than 9999 to a format easy to read, with the digits grouped by threes. This grouping has traditionally been done by using a comma, but is done here using a space as is the style in metric usage. Users who may wish to use the traditional format with a comma between the thousands and ten-thousands digits, can alter the concatenation in statement 766 by inserting +","+ in place of +""+.

In the original program, commentary statement 9040 assigns TOT to represent the total energy output, but the operating variable appears to be TT, as in statements 765 and 1420. Variable BL$, used in the PET version in statements 40, 920, 960, 1000, 1120, etc, consists of 36 spaces followed by cursor home, and is used to clear one line on the screen.

In the original program, statements 1210 and 1220 are used to generate a random damage factor for the primary and secondary coolant loops. There is a 5% change of primary loop damage whenever the primary coolant flow exceeds 90%, and an 8% chance of secondary loop damage whenever the secondary coolant flow exceeds 90%. This damage shows up as a leakage rate, which is simply a count of the number of times the random factor occurs. The leakage accumulates in each coolant system, and a shutdown is forced when leakage reaches 5 in either system.

In running this program many times, I got the feeling that each run was much the same as every other run, and that the leakage factor was a bit too simple. All one had to do was keep the coolant flows below 90% and everything would go well almost indefinitely. I decided to alter the random leakage factors to a more interesting and a more realistic format, using three ideas: quality of workmanship, multi-step flow-dependent random damage, and age-dependent random damage.

First, a construction or repair job can be performed well or poorly. Two new variables were introduced, QP% and QS%, representing the quality of the materials and workmanship in the primary and secondary coolant loops. These variables are set equal to 1 to represent first-rate quality, to 2 to represent second-rate, and to 3 to represent third-rate. The values of QP% and QS% are selected independently of each other, to reflect the fact that sometimes one job is done well while the other is not. In running the simulation, this means that a leakage shutdown will sometimes be due to primary leakage, sometimes to secondary trouble. The values of QP% and QS% are defined on startup at statements 430 and 440, and redefined at 2020 and 2030 after a maintenance shutdown.

In selecting the values of QP% and QS%, a probability of 0.57, the square root of 0.33, is used as the threshold between first-rate and inferior quality. This means that one startup between first-rate and inferior coolant systems is first-class condition. The remaining startups will occur with one or both coolant systems impaired. As the simulation runs, QP% and QS% are used at statements 1210 and 1220 to select different damage probabilities for each coolant system.

Second, a three-step flow-dependent random damage factor has been introduced. Let's use statements 1211 and 1212 as an example. These statements define the probability of a leak occurring in the primary coolant system when the workmanship is of first-class quality. When the primary coolant flow PF% is greater than 65, there is 1 chance in 5000 of a leak occurring on any given day of operation. When the flow rate exceeds 90 the probability of a leak increases to 1 in 250, and it reaches 1 in 20 when the flow exceeds 95. With lower-quality workmanship, the flow thresholds are reduced and the damage probabilities are increased. In the primary coolant system the flow thresholds are slightly lower than in the secondary system, but the probabilites of leakage are slightly less.

This represents a sneaky pedagogical trick, introducing the idea of a rate of change in a situation where it is vitally useful.

Third, a plant aging factor has been inserted, which slowly increases the probability of a leak occurring in either cooling system as the plant accumulates operating days. These aging factors are the last terms in statements 1212, 1214, 1216, 1222, 1224, and 1226. The aging factors for poorer-quality systems have higher probabilities of leakage.

My statements 1210 to 1226 can be removed and the original statements 1210 and 1220 can be reinstated, and the PET simulation will continue to operate properly. Alternatively, users can rewrite these statements to suit their own ideas about these leakage probabilities.

GO% was used as a variable in the original program, for example in line 1380. Unfortunately, this is an illegal variable in the PET. It has been replaced with GZ%, representing turbine-generator power output.

As Berggren noted in his documentation, this program "makes extensive use of logic evaluations within expressions. For example, (A > 100) equals one if true and zero if false." The PET handles such logic expressions, but returns a *negative* one if true, and zero if false. This means that all logical expressions must have their signs changed, in translating from Apple to PET Basic. To see the effect of this, compare statements 1212, 1214, etc. At first glance it would appear that these aging factors operate to reduce leakage, since they are subtracted. But the effect is additive, because we are subtracting a negative value.

In the PET version, time delays have been added to slow down the rate at which text is thrown on the screen. The time-delay subroutine starts at line 5300, and uses variable Z4 to control the time delay. Z4 is calibrated roughly in tenths of a second. In line 48 for instance, Z4 is set equal to 8. This means the next delay will be about 8 tenths of a second. Z4 is automatically incremented by 3 each time the delay routine is used. This has the effect of starting down the screen fairly quickly, then gradually slowing down as the screen fills. The delays can be adjusted by changing the Z4 coefficient in line 5300. Coefficients greater than 63 will increase the delays, less then 63 will reduce them. To prevent insanity during debugging, it is recommended that the 63 be reduced to about 6. When everything is running, restore it to a suitable value.

After this simulation run is completed, that is, when the fuel charge has been exhausted, the program offers a comment on the operator's competence. The comment is selected by calculations performed in line 4050 in the Apple version, or in lines 4020-4022 in the PET version. Additional comments have been added to the PET version, and the thresholds have been lowered, to give a bit more encouragement to the beginner. Operation at a load factor of 60% is considered to be acceptable, and a load factor of 70% is considered good. I believe these interpretations are not substantially different from those prevailing in the industry.

Finally, the screen display of operating information presented difficulties in completing the adaptation. While the Apple instructions VTAB and HTAB were easy to interpret, I couldn't figure out what CALL-958 or CALL-922 (lines 1165 and 1170) might mean. To get around this, I did a complete rewrite on this program. I can't venture an opinion whether my version is better or worse than the original, because I have no idea how the original works. However, I added a couple of features which I believe are not present in the Apple version. The PET version gives the equipment temperatures as does the Apple version, but in addition the PET

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gives the change from the previous readout. This is of considerable help to the operator. The operating response to a reactor core temperature of 740 degrees will be different, depending on whether this represents a decrease of 5 degrees, an increase of 5 degrees, or an increase of 50 degrees compared to the previous temperature. This also represents a sneaky pedagogical trick, introducing the idea of a rate of change in a situation where it is vitally useful, in an attempt to foster a better understanding of the general significance of rates.

Another innovation (at least I think it is an innovation) is the continuous reporting of the leakage rates, regardless of whether they are serious enough to require shutdown. This enables the operator to judge more clearly how events are developing, and adds some dramatic suspense: "The blasted secondary leakage is up to 4 L/day, and I've just got the plant settled down at 1820 kW. How long can I continue?" Leakages have been given the physical unit of litres per day.

I have suppressed the "low power output" warning during the first eight days after a startup, to give the operator a fighting chance to get the plant under way. This suppression is performed in line 464, and uses variable D4% to identify the startup day.

In this version, the trouble warnings are presented on the screen in a frame separate from the operating conditions frame. Statement 472 suppresses the warning frame if no warnings are to be displayed, while lines 462-470 decide whether to override the suppression. The warning frame presents both warnings of out-of-range operating conditions and reports of damaged equipment. Variable SW is used to state "None" if this frame is activated but there is either no warning or no reportable damage. In the Apple version, line 4040 uses the phrase "kilowatts per day," and 770 contains a similar phrase. These have been corrected.

When an operating readout comes up on the screen, the program asks for four control settings, in turn: control rods, emergency coolant flow, primary coolant flow, and secondary coolant flow. If the current value of any of these is to remain unchanged, press the up-arrow "↑" without putting in a number. If all values are to remain unchanged, press ↑ four times. If a value is to be changed, type in the new value, terminated by ↑. The input routine will automatically terminate each entry if three digits are input. As in Berggren's program, these variables are each set to a value from 0 to 100.

The Control setting input routine, statements 10-15, does not include a delete feature. This omission is deliberate, to reflect the "unforgiving" nature of

```
0 REM  NUCLEAR POWER PLANT SIMULATION
1
2 REM  FOR PET COMPUTER
3
4 REM  BY IVAN SMITH & HUME SMITH
5
6 REM  BASED ON S. R. BERGGREN, CREATIVE COMPUTING DECEMBER 1980 PAGE 128 FF
7 :
8 REM  REVISED 23 DECEMBER 1980
9 GOTO40
10 POKE158,0:B$="":PRINT" ";:POKE167,0
11 GETA$:IFA$=""THEN11
12 Z=ASC(A$):IFZ=94THEN15
13 IFZ<48ORZ>57THEN11
14 PRINTA$,:B$=B$+A$:IFLEN(B$)<3THEN11
15 POKE167,1:PRINT" ";:RETURN
40 POKE59468,14:R=PND(-TI):BL$="                                                                    "
41 T1$=""          TI  /<L"9_ TO"_ L9/!"
42 T2$="N          ♦!♦!,♦ _-T_!, -♦ !"
44 PRINT"ↁ♦"T1$:PRINTSPC(7)"XBV  ♦!"I/"_ _ !"-!!-/" :Z4=7:GOSUB5300
45 PRINTSPC(5)"ANRS MODIFIED BY THE STAFF OF"
48 PRINT"M !-~!"O♦!"_  !+! ♦"ITL, /<♦ ♦"TL\♦"  :GOSUB5300:Z4=8
50 PRINT"ↁWHIS PROGRAM SIMULATES THE OPERATION OF"
60 PRINT"ↁA NUCLEAR POWER REACTOR.": GOSUB5300:PRINT"  THE OBJECT"
70 PRINT"WIS TO OPERATE THE PLANT AT AS HIGH A"
80 PRINT"↓POWER OUTPUT AS POSSIBLE", : GOSUB5300:PRINT", WITHOUT"
90 PRINT"↓CAUSING A REACTOR MELTDOWN.": GOSUB5300
92 FORZ5=1TO7:PRINTTAB(18)"↑↑MELTDOWN■": FORZ6=1TO50:NEXTZ6
94 PRINTTAB(18)"↑MELTDOWN":FORZ6=1TO50:NEXTZ6,Z5:GOSUB5310
100 PRINT"ↁDO YOU WANT INSTRUCTIONS"; :INPUTZ$:IFZ$="N"THEN350
102 IFZ$(>"Y"THEN100
110 PRINT"ↁTHE ↓CONTROL RODS■ ADJUST THE AMOUNT OF"
120 PRINT"↓HEAT PRODUCED BY THE REACTOR.": Z4=11:GOSUB5300
130 PRINT"WTHE ↓PRIMARY COOLANT■ TRANSFERS THIS"
140 PRINT"↓HEAT TO THE HEAT EXCHANGER.": GOSUB5300
142 PRINT"WTHE ↓SECONDARY COOLANT■ PICKS UP HEAT"
144 PRINT"↓FROM THE HEAT EXCHANGER", : GOSUB5300:PRINT", AND TRANSFERS"
150 PRINT"↓IT TO THE ↓TURBINE■", : GOSUB5300:PRINT", WHICH DRIVES"
160 PRINT"↓THE ELECTRIC GENERATOR.", : GOSUB5300:PRINT"  THE SECONDARY"
170 PRINT"↓COOLANT THEN GOES TO THE ↓COOLING TOWER■.": GOSUB5300
180 PRINT"↓AND THEN BACK TO THE HEAT EXCHANGER.": GOSUB5300:GOSUB5310
190 PRINT"ↁTHE ↓EMERGENCY COOLANT■ IS USED TO HELP"
192 PRINT"↓SHUT DOWN THE REACTOR": Z4=11:GOSUB5300:PRINT" WHEN OTHER SYSTEMS"
194 PRINT"FAIL.": GOSUB5300:PRINT"WALIKE THE OTHER COOLANTS,"
196 PRINT"↓EMERGENCY COOLANT IS NOT RECYCLED.": GOSUB5300
198 PRINT"↓IN HIS MEANS YOUR SUPPLY OF EMERGENCY"
200 PRINT"↓COOLANT IS LIMITED.": GOSUB5300:GOSUB5310:Z4=13
202 PRINT"↓AN INCREASED FLOW OF PRIMARY COOLANT"
204 PRINT"↓WILL LOWER THE REACTOR CORE TEMPERATURE": GOSUB5300
206 PRINT"↓AND WILL RAISE THE HEAT EXCHANGER"
208 PRINT"↓TEMPERATURE.": GOSUB5300
210 PRINT"↓AN INCREASED FLOW OF SECONDARY COOLANT"
212 PRINT"↓WILL LOWER THE HEAT EXCHANGER" PRINT"↓TEMPERATURE"; GOSUB5300
214 PRINT", AND WILL INCREASE THE" PRINT"↓POWER GENERATED"; GOSUB5300
216 PRINT", BUT WILL RAISE THE"
218 PRINT"↓COOLING TOWER TEMPERATURE.": GOSUB5300:GOSUB5310:Z4=13
220 PRINT"ↁSUCCESSFUL OPERATION DEPENDS ON"
222 PRINT"↓GETTING A BALANCE": GOSUB5300
224 PRINT", BETWEEN THE" PRINT"↓HIGH TEMPERATURES NEEDED FOR"
226 PRINT"↓POWER GENERATION"; :GOSUB5300:PRINT" AND THE"
228 PRINT"↓TEMPERATURE LIMITS OF THE MACHINERY.": GOSUB5300:GOSUB5310
230 PRINT"ↁ■■■ENTER  ←  TO SEE REACTOR DIAGRAM,"
232 PRINT"↓ENTER  ↘  FOR WORKING INSTRUCTIONS,"
234 PRINT"↓ENTER  ♦  TO START OPERATION."
236 PRINT"↓TAB(13); :INPUTA$ IFA$="D"THENGOSUB6000 GOTO220
237 IFA$="S"THEN390
238 IFA$(>""THEN226
240 PRINT"ↁTHE CONTROLS ARE OPERATED BY TYPING IN"
245 PRINT"↓THE DESIRED CONTROL ROD SETTING"; Z4=13:GOSUB5300:PRINT" AND"
250 PRINT"↓FLOW RATES.": GOSUB5300:PRINT"■W.SE VALUES FROM 0 TO 100.": GOSUB5300
252 PRINT"  ↘F NO ENTRY" PRINT"■IS MADE, THE PREVIOUS SETTINGS WILL
254 PRINT"■REMAIN UNCHANGED.": GOSUB5300
256 PRINT"■↘SE "CHR$(34)"↑"CHR$(34)" TO STEP TO THE DIFFERENT"
258 PRINT"■FUNCTIONS.": GOSUB5300:PRINT"  WHEN THE DESIRED"
260 PRINT"■ENTRIES HAVE BEEN MADE, THE" PRINT"■NEXT DAY'S CONDITIONS",
265 PRINT" WILL BE" PRINT"■CALCULATED.": GOSUB5300:GOSUB5310
270 PRINT"ↁTHE REACTOR CAN BE KEPT OPERATING UNTIL"
272 PRINT"↓THE REACTOR FUEL IS EXHAUSTED": Z4=13:GOSUB5300:PRINT", OR"
274 PRINT"↓UNTIL A MELTDOWN OCCURS.": GOSUB5300
276 FORZ5=1TO7:PRINTTAB(8)"↑↑MELTDOWN■": FORZ6=1TO50:NEXTZ6
278 PRINTTAB(8)"↑MELTDOWN":FORZ6=1TO50:NEXTZ6,Z5
280 PRINT"↓WHE FUEL WILL LAST ABOUT 100 TO 150"
282 PRINT"↓DAYS"; GOSUB5300:PRINT", DEPENDING ON HOW MUCH"
```

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CIRCLE 250 ON READER SERVICE CARD

nuclear technology. If an operating error is made, its consequences must be endured, at least for one operating cycle. If an operator types 80 for a control rod setting when 8 was intended, the computer will give a vivid illustration of the consequences of such an error, and the operator will learn a few things as he tries to salvage the plant in subsequent cycles. I have made such errors, and have found the results to be "interesting." If a user wishes to include a delete function, the input routine should be replaced by the following:

```
10 Same as existing 10
11 Same as existing 11
12 Z=ASC(A$):IFZ=94THEN17
13 IFZ=20ANDLEN(B$)=1THENB$
   ="":?CHR$(20);:GOTO11:REM
   DELETE
14 IFZ=20ANDLEN(B$)=2THENB$
   =LEFT$(B$,1):?CHR$(20);:
   GOTO11
15 Same as existing 13
16 Same as existing 14
17 Same as existing 15
```

In watching students run the program, it was noted that the ↑ would sometimes be pressed five or six times, once or twice more that the required four. The extra characters remained in the keyboard input buffer, and caused the program to skip over the first one or two control inputs on the next cycle, which created unnecessary difficulties. To eliminate this, POKE 158,0 was inserted in line 10. This sets the keyboard input buffer counter to zero at the start of each input, eliminating any spurious characters which might be lurking in the buffer. The POKE 167,0 in line 10 turns the cursor on, while the POKE 167,1 in line 15 turns it off.

The POKE 216 used in lines 920, 930, 5310, etc., positions the cursor on a screen line. POKE 216,n:? positions the cursor on line n+2. For example, POKE 216,17:? places the cursor on line 19 for the next print. The POKE 216,n must be followed by a blind PRINT instruction, otherwise it won't take effect.

The PET nuclear plant simulation occupies 14.1K of memory, and presumable will work in a 16K machine. I used a 32K PET model 2001-32N.

Berggren claimed his program "is almost entirely crashproof," a statement which drew the rejoinder "famous last words." I have seen this program run more than fifty times by a variety of inexperienced operators, and have yet to see a crash. Berggren's claim seems to be justified.

I think Berggren's simulation is the most useful education program ever published by *Creative Computing*. It can form a foundation for variations which simulate other reactor types, or which go into greater detail, and it may serve as inspiration for other simulations. □

```
284 PRINT"▪EMERGY IS PRODUCED EACH DAY.": GOSUB5300
290 PRINT"▪DWN▪ THE FUEL IS EXHAUSTED. YOUR"
295 PRINT"▪PERFORMANCE WILL BE SUMMARIZED.": GOSUB5300:GOSUB5310
300 PRINT"▫.F YOU WANT TO REPAIR DAMAGE OR REPLACE": PRINT"▪COOLANT". Z4=11
305 GOSUB5300:PRINT", DRING THE REACTOR TEMPERATURE"
310 PRINT"▪DOWN BELOW 100": GOSUB5300:PRINT", AND SHUT OFF THE"
315 PRINT"▪COOLANT FLOWS.": GOSUB5300:PRINT"  THIS WILL CAUSE"
320 PRINT"▪AN AUTOMATIC MAINTENANCE SHUTDOWN.": GOSUB5300
325 PRINT"▪REPAIRS WILL BE MADE": GOSUB5300:PRINT", AND ALL COOLANT"
330 PRINT"▪WILL BE REPLENISHED.": GOSUB5300
335 PRINT"▪DWN▪E GREATER THE DAMAGE. THE LONGER"
340 PRINT"▪THE REPAIRS WILL TAKE.": GOSUB5300:GOSUB5310
350 PRINT"▫TAB(13)"▪DWNDRAGE▪◤▬◣▬◤▬!"
355 PRINTTAB(7)"▪MN▪ ▪▪ TO▬ ▬L▪◤!▪▪"
360 PRINTTAB(3)"▪DW▪T ▪◤Γ▫▪!◣▬ ▪▪▬▬Γ▬ Γ▬▬◣▬▬◤!!" Z4=13:GOSUB5300
362 PRINT"▪DW▪H▪ OPERATOR", Z4=4 GOSUB5300:PRINT", (YOU)": GOSUB5300
364 PRINT", IS RESPONSIBLE"
366 PRINT"▪FOR SAFE OPERATION OF ALL EQUIPMENT."
370 GOSUB5300:GOSUB5310:GOTO220
390 REM  INITIATE
400 GOSUB2000
410 RH=0:RL=0:TT=0
420 DAY%=0:D4%=0
430 QP%=1-(RND(2)>.57)-(RND(2)>.95)
440 OS%=1-(RND(2)>.57)-(RND(2)>.95)
442 REM  QP%=QUALITY OF PRIMARY LOOP WORKMANSHIP, OS%=SAME FOR SECONDARY LOOP
444 REM  1 FOR FIRST-CLASS WORK, 2 FOR SECOND-CLASS, 3 FOR THIRD-CLASS
450 DMGE2=0
455 A2=0:A1%=0:A2%=0
460 DAY%=DAY%+1 PRINT"▫";: REM  WRITE REPORT
462 IFRT%>900ORXT%>500ORCT%>300ORGZ%>2000THEN480
464 IFGZ%<1000RNDCDAY%-D4%*8)THEN480
466 IFEV%<200ORPV%<100ORSV%<100THEN480
468 IFRD%>30RPD%>40RSD%>40REDN%>2THEN480
470 IFPB%>0ORSB%>0ORXB%>0ORGB%>0THEN480
472 GOTO700
480 PRINT1$
490 PRINTT2$;DAY%;"▪"
500 PRINT"▪◆▬◣▬◤!▪▪"▪SW=1
510 IFRT%<800THEN520
512 PRINT"    REACTOR OVERHEATED":RD%=RD%+1-(RT%>850)-(RT%>900)-2*(RT%>950)
514 PD%=PD%+1:ED%=ED%+1-(RT%>850):SW=2
520 IFXT%<500THEN530
522 PRINT"    HEAT EXCHANGER OVERHEATED"
524 XD%=XD%+1-(XT%>600):PD%=PD%+1:SD%=SD%+1:SW=2
530 IFGZ%<2000THEN540
532 PRINT"    TURBINE OVERLOADED"
534 TD%=TD%+1-(GZ%>2500):SD%=SD%+1:SW=2
540 IFCT%>300THENPRINT"    COOLING TOWER OVERHEATED":SD%=SD%+1:SW=2
550 IFGZ%<1000THENPRINT"    TOWER OUTPUT LOW":SW=2
560 IFEV%<200THENPRINT"    EMERGENCY COOLANT LOW":SW=2
570 IFPV%<100THENPRINT"    PRIMARY COOLANT LOW":PD%=PD%+1:SW=2
580 IFSV%<100THENPRINT"    SECONDARY COOLANT LOW":SD%=SD%+1:SW=2
590 ONSWGOTO600,610
600 PRINTTAB(11)"▫ONE"
610 PRINT"▪▪ ◆▫▪ ▪▪":SW=1
620 IFRD%<3THENPRINT"REACTOR CORE DAMAGED":SW=2
630 IFPD%<5THEN640
632 PRINT"PRIMARY COOLANT LEAK ";PD%;"L/DAY"
634 PV%=(PV%-PD%)*(-(PV%-PD%)>0):SW=2
640 IFSD%<5THEN650
642 PRINT"SECONDARY COOLANT LEAK ";SD%;"L/DAY"
644 SV%=(SV%-SD%)*(-(SV%-SD%)>0)):SW=2
650 IFED%<3THEN660
652 PRINT"EMERGENCY COOLANT LEAK ",2*ED%;"L/DAY"
654 EV%=(EV%-2*ED%)*(-((EV%-2*ED%)>0)):SW=2
660 IFPB>0THEN670
662 PRINT"PRIMARY COOLANT PUMP FAILURE"
664 PRINT10*PD%*(-(PD%<10)+100*(-(PD%>10)),"%":SW=2
670 IFSB%=0THEN680
672 PRINT"SECONDARY COOLANT PUMP FAILURE"
674 PRINT10*SD%*-(SD%<10)+100*-(SD%>10)),"%":SW=2
680 IFXB%>0THENPRINT"HEAT EXCHANGER FAILURE":SW=2
690 IFGB%>0THENPRINT"TURBINE FAILURE":SW=2
694 ONSWGOTO694,696
694 PRINTTAB(11)"▫ONE"
696 GOSUB5310
700 PRINT"▫"T1$:PRINTT2$;DAY%
710 IFRD%>5THENPRINT"▪▪ ▪▫▬L▪▬Γ▫▪/!▪ ▪▫▬L▪▬Γ▫▪/!▪ ▪▫▬L▪▬Γ▫▪/!" GOTO3000
720 PRINT"▪▪"                ▬▬▬
```

```
744 T%=XT%
750 PRINT"  -COOLING TOWER  300"
752 PRINTTAB(25)"T"CT%-T%: PRINTAB(33)"T"CT%
754 T%=CT%
760 PRINT"%          TOWER OUTPUT (MAX. 2000) "GZ%"KO"
762 KW%=TT/DAY%: VE=INT(.24*TT*.055)
764 VE$=STR$(VE):IFVE<10000THENVE$=" "+VE$ GOTO770
766 VE$=" "+LEFT$(VE$,LEN(VE$)-3)+" "+RIGHT$(VE$,3)
770 PRINT"                 AVERAGE POWER OUTPUT:"KW%"KO"
780 PRINT"  >ALUE OF ENERGY PRODUCED  "VE$
790 PRINT"%-COOLANTS:                L">"L  L"+"#!"     -L"O"
800 PRINT"     "EMERGENCY"TAB(16)EV%TAB(22)ED%"L/DAY"TAB(33)EF%
810 PRINT"     "RIMARY"TAB(16)PV%TAB(22)PD%"L/DAY"TAB(33)PF%
820 PRINT"     "ECONDARY"TAB(16)SV%TAB(22)SD%"L/DAY"TAB(33)SF%
830 IF(100-RL)<5THENPRINT"%MOLERCTOR FUEL EXHAUSTED":GOTO4000
900 REM  GET NEW CONTROL VALUES
910 A2%=A1%:A1%=A%
920 POKE216,23:PRINT:PRINTBL$
930 POKE216,23:PRINT:PRINT"-ONTROL ROD POSITION?";:GOSUB10
940 IFB#=""THEN960
950 A%=VAL(B$):A%=A%+(100-A%)*(-(A%>100))
960 POKE216,23:PRINT:PRINTBL$
970 POKE216,23:PRINT:PRINT"MERGENCY COOLANT FLOW?";:GOSUB10
980 IFB#=""THEN1000
990 EF%=VAL(B$):EF%=EF%+(100-EF%)*(-(EF%>100))
1000 POKE216,23:PRINT PRINTBL$
1010 POKE216,23:PRINT:PRINT"RIMARY COOLANT FLOW?",:GOSUB10
1020 IFB#=""THEN1040
1030 PF%=VAL(B$):PF%=PF%+(100-PF%)*(-(PF%>100))
1040 POKE216,23:PRINT:PRINTBL$
1050 POKE216,23:PRINT:PRINT"#ECONDARY COOLANT FLOW?";:GOSUB10
1060 IFB#=""THEN1100
1070 SF%=VAL(B$):SF%=SF%+(100-SF%)*(-(SF%>100))
1100 IFPF%=0ANDSF%=0ANDNK<1ANDRT%<100ANDAX%=0THEN1120
1110 GOTO1140
1120 GOSUB2000:POKE216,23:PRINT:PRINTBL$
1122 POKE216,23:PRINT:PRINT"%AINTENANCE SHUTDOWN:"MD%"DAYS.?"
1130 FOR1=1TO5000:NEXT1
1140 IFEF%<EV%THENEF%=EV%
1200 REM  DAMAGE ASSESSMENT AND OPERATION CALCULATIONS
1205 EV%=EV%-EF%+2*ED%*(ED%>0)
1210 OMGF%GOTO1211,1213,1215 REM LEAKAGE PROBABILITIES
1211 PD%=PD%+(PF%>65)*(RND(2)>.9998)+(PF%>90)*(RND(2)>.996)
1212 PD%=PD%+(PF%>95)*(RND(2)>.95)-(4000*RND(2)<DAY%)*GOTO1220
1213 PD%=PD%+(PF%>55)*(RND(2)>.9995)+(PF%>80)*(RND(2)>.993)
1214 PD%=PD%+(PF%>92)*(RND(2)>.94)-(2700*RND(2)<DAY%)*GOTO1220
1215 PD%=PD%+(PF%>40)*(RND(2)>.999)+(PF%>70)*(RND(2)>.985)
1216 PD%=PD%+(PF%>87)*(RND(2)>.93)-(1400*RND(2)<DAY%)
1220 ONGS%GOTO1221,1223,1225
1221 SD%=SD%+(SF%>75)*(RND(2)>.9997)+(SF%>93)*(RND(2)>.995)
1222 SD%=SD%+(SF%>97)*(RND(2)>.94)-(3000*RND(2)<DAY%)*GOTO1230
1223 SD%=SD%+(SF%>60)*(RND(2)>.9992)+(SF%>85)*(RND(2)>.99)
1224 SD%=SD%+(SF%>94)*(RND(2)>.92)-(2400*RND(2)<DAY%)*GOTO1230
1225 SD%=SD%+(SF%>40)*(RND(2)>.9985)+(SF%>78)*(RND(2)>.98)
1226 SD%=SD%+(SF%>89)*(RND(2)>.9)-(1800*RND(2)<DAY%)
1230 PB%=-(PD%>5)
1240 SB%=-(SD%>5)
1250 IFPF%<(100-PD%*10)ANDPB%>0THENPF%=(100-PD%*10)*(-(100-PD%*10>0)
1260 IFSF%<(100-SD%*10)ANDSB%>0THENSF%=(100-SD%*10)*(-(100-SD%*10>0)
1270 RL=RL+RH/50
1280 RH=(A2%*30+A1%*60+A2%*10)/2500*(100-RL)
1300 PH=PF%*(100*(-(PV%>100))+PV%*(-(PV%<=100)))/350
1310 EH=EF%/200*(RT%-25)
1320 RT%=RT%+RH-EH-PH-5*(-(RT%>25))
1325 RT%=25+(RT%-25)*(-(RT%>25))
1330 XT%=(RT%-25)*PF%+(CT%-25)*SF%)/(PF%+SF%+1)+25
1340 IFXB%>0THENXT%=RT%.8+5
1350 SH=SF%*(100*(-(PV%>100))+PV%*(-(PV%<=100)))/350*(XT%-CT%)
1360 IFWB%>0THENSH=SH*.2
1370 GZ%=SH/XT%*(XT%-CT%)*2/3
1375 IFGZ%>2600THENGZ%=2600
1380 GZ%=GZ%*(-(GZ%>0))*(-(GB%=0))
1390 CT%=25+(XT%-25)*(SH-GZ%)/(SH+1)*.75
1395 CT%=25*(-(CT%<25))+CT%*(-(CT%>25))
1400 IFXB%<1THENXB%=(-(XD%>2))*(-(RND(4)>.9))
1410 IFGB%<1THENGB%=(-(GD%>4))*(-(RND(4)>.9))
1420 TT=TT+GZ%
1430 GOTO460
2000 REM  MAINTENANCE REPAIR SUBROUTINE
2010 EV%=300 PV%=120:SV%=120
2020 QP%=1-(RND(2)>.57)-(RND(2)>.95)
2030 QS%=1-(RND(2)>.57)-(RND(2)>.95)
2040 RT%=25:TT%=25
2050 XT%=25:TB%=25
2060 CT%=25:TS%=25
2070 DMGE%=DMGE%+2*RD%+ED%+PD%+VD%+SD%+GD%
2080 MD%=5+3*(10*(-(RD%>3))-(ED%>3)-(PD%>3)-(SD%>3)+2*PB%+2*SB%+3*XB%+3*GB%)
```


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CIRCLE 197 ON READER SERVICE CARD

Power Plant, continued...

```
2082 DAY%=DAY%+MD%:D4%=DAY%
2090 RD%=0
2100 ED%=0
2110 PD%=0
2120 XD%=0
2130 SD%=0
2140 GD%=0
2150 PB%=0
2160 SB%=0
2170 XB%=0
2180 GB%=0
2190 EF%=0:PF%=0:SF%=0
2195 GZ%=0
2200 RETURN
3000 PRINT"[HOME][DOWN]" REM  MELTDOWN ENDING
3010 IFRD%>6GOTO3100
3015 PRINT"[RVS]  THE REACTOR CORE HAS BEEN DESTROYED"
3020 PRINT"BY UNCONTROLLED THERMAL RUNAWAY."
3025 PRINT"  HOWEVER, THE CONTAINMENT BUILDING HAS"
3030 PRINT"NOT YET RUPTURED."
3035 PRINT"[RVS]  INITIATE YOUR EVACUATION PLAN." GOTO3200
3100 PRINT"[RVS]  THE REACTOR CORE HAS MELTED DOWN AND"
3105 PRINT"PRODUCED A STEAM EXPLOSION, THE"
3110 PRINT"CONTAINMENT BUILDING HAS RUPTURED."
3115 PRINT"LETHAL RADIOACTIVE GASSES AND DEBRIS"
3120 PRINT"HAVE ESCAPED."
3125 PRINT"[RVS]  INITIATE YOUR EVACUATION AND"
3130 PRINT"RADIATION CLEANUP PLANS AND GET MEDICAL"
3135 PRINT"ASSISTANCE."
3200 PRINT"[HOME]"
3210 FORZ5=1TO30
3220 PRINT"[7 SPACES][SHIFT-*][SHIFT-O][RVS] [OFF][SHIFT-O][SHIFT-*]"
3230 FORZ6=1TO100-3*Z5:NEXTZ6
3240 PRINT"[7 SPACES][SHIFT-*][SHIFT-O][RVS] [OFF][SHIFT-O][SHIFT-*]"
3250 FORZ6=1TO100-3*Z5:NEXTZ6
3260 NEXTZ5
3270 POKE216,21:PRINT:GOTO5000
4000 REM EVALUATION OF GAME
4005 PRINT"[CLR]  OVER A PERIOD OF"DA%"DAYS, YOU HAVE"
4010 PRINT"PRODUCED AN AVERAGE POWER OUTPUT OF"
4015 PRINT"[HOME]"K%"KW."
4020 AK%=(-(KW%>799)-(KW%>899)-(KW%>999)-(KW%>1099)-(KW%>1199)-(KW%>1299)
4022 AK%=AK%-(KW%>1399)-(KW%>1499)
4025 PRINT"[RVS]  OUR AVERAGE POWER PRODUCTION RATE IS"
4030 ONAK%GOTO4032,4034,4036,4038,4040,4042,4044,4050,4055
4032 PRINT"INCREDIBLE!  FIND A LESS DEMANDING JOB." GOTO4060
4034 PRINT"BAD,  OUR AREA HAD" PRINT"FREQUENT BLACKOUTS." GOTO4060
4036 PRINT"PRETTY BAD.  OUR AREA HAD" PRINT"OCCASIONAL BLACKOUTS." GOTO4060
4038 PRINT"WAY BELOW YOUR AREA'S POWER NEEDS." GOTO4060
4040 PRINT"NOT GOOD.  OUR AREA HAD BROWNOUTS." GOTO4060
4042 PRINT"NOT BAD.  OUR AREA'S POWER NEEDS"
4043 PRINT"WERE SUPPLIED - JUST." GOTO4060
4044 PRINT"ADEQUATE.  YOU COULD DO BETTER." GOTO4060
4050 PRINT"EXELLENT!  TOWER RATES IN YOUR AREA WILL"
4051 PRINT"NOT BE INCREASED." GOTO4060
4055 PRINT"NEAR THE MAXIMUM!  TOWER COSTS IN YOUR"
4056 PRINT"AREA WILL DROP SIGNIFICANTLY."
4060 GOSUB2000
4065 D%=1-(DM%>10)-(DM%>20)-(DM%>30)
4070 PRINT"[RVS]  THE EQUIPMENT DAMAGE SUSTAINED WAS"
4075 ONDZGOTO4080,4085,4090,4095
4080 PRINT"VERY LIGHT." GOTO5000
4085 PRINT"MODERATE." GOTO5000
4090 PRINT"SERIOUS." GOTO5000
4095 PRINT"SEVERE."
5000 REM END
5005 INPUT"[RVS]OULD YOU LIKE TO TRY AGAIN";A$:A$=LEFT$(A$,1)
5010 IFA$="Y"THENGOSUB2000:GOTO390
5015 PRINT"[CLR]":END
5100 B$=""
5105 FORI=1TO4
5110 GETA$
5130 IFASC(A$)<>94THEN5140
5134 IFB$=""THENRETURN
5136 OUT5,WAL(B$)
5138 RETURN
5140 IFASC(A$)>=13THENSV$0583:GOTO1170
5150 B$=B$+A$
5160 PRINTA$;
5170 NEXTI
5180 RETURN
5300 FORJ6=1TO63*Z4:NEXTJ6:Z4=Z4+3:RETURN:REM DELAY
5310 POKE216,23:PRINT:PRINT"  [RVS]PRESS ● [OFF] TO CONTINUE...";
5311 WAIT59410,4,4:POKE216,23:PRINT:PRINTBL$:GETZZ$:RETURN
6000 ZD$="[RVS][SHIFT-*][SHIFT-O][SHIFT-*][SHIFT-O]"
6005 PRINT":"PRINTZD$"[HIS IS THE REACTOR VESSEL                    "
```

```
6010 PRINT"[illegible]"
6015 PRINT"[illegible]"
6020 FORZZ=1T04 PRINT"[illegible]" NEXT
6025 PRINT"[illegible]"
6030 PRINT"[illegible]"
6035 PRINT"[illegible]"
6040 Z4=11 GOSUB5300 GOSUB5310
6050 PRINTZD$"THIS IS THE CORE                    "Y"
6055 PRINT"[illegible]"
6060 FORZZ=1T03 PRINT"[illegible]" NEXT
6065 GOSUB5300 GOSUB5310
6070 PRINTZD$"THIS IS THE EMERGENCY COOLANT       "Y"
6075 PRINT"[illegible]"
6080 PRINT"[illegible]"
6085 PRINT"[illegible]"
6086 PRINT"[illegible]"
6090 PRINT"[illegible]"
6095 PRINT"[illegible]"
6096 PRINT"[illegible]"
6097 FORZZ=1T03:PRINT" ":NEXT
6100 GOSUB5300 GOSUB5310
6105 PRINTZD$"THESE ARE THE CONTROL RODS          "Y"
6110 PRINT"[illegible]"TAB(5)"[illegible]"
6115 PRINTTAB(5)"[illegible]"
6120 PRINTTAB(5)"[illegible]"
6125 PRINTTAB(5)"[illegible]"
6126 PRINTTAB(5)"[illegible]"
6130 Z4=11 GOSUB5300 GOSUB5310
6135 PRINTZD$"THIS IS THE PRIMARY COOLANT LOOP    "Y"
6140 PRINT"[illegible]"TAB(12)"[illegible]"
6150 PRINTTAB(12)"[illegible]"
6155 PRINTTAB(13)"[illegible]"
6156 PRINTTAB(13)"[illegible]"
6160 PRINTTAB(8)"[illegible]"
6165 PRINTTAB(15)"[illegible]"
6170 PRINTTAB(8)"[illegible]"
6175 GOSUB5300 GOSUB5310
6180 PRINTZD$"THIS IS THE HEAT EXCHANGER          "Y"
6185 PRINT"[illegible]"TAB(14)"[illegible]"
6190 PRINTTAB(14)"[illegible]"
6195 PRINTTAB(14)"[illegible]"
6200 PRINTTAB(14)"[illegible]"
6205 PRINTTAB(14)"[illegible]"
6210 Z4=11 GOSUB5300 GOSUB5310
6220 PRINTZD$"THIS IS THE SECONDARY COOLANT LOOP  "Y"
6225 PRINT"[illegible]"TAB(17)"[illegible]"
6230 PRINTTAB(17)"[illegible]"
6235 PRINTTAB(18)"[illegible]"
6236 PRINTTAB(18)"[illegible]"
6240 PRINTTAB(16)"[illegible]"
6250 PRINTTAB(16)"[illegible]"TAB(33)"[illegible]"
6255 PRINTTAB(16)"[illegible]"TAB(33)"[illegible]"
6260 PRINTTAB(18)"[illegible]"TAB(33)"[illegible]"
6265 PRINTTAB(18)"[illegible]"TAB(33)"[illegible]"
6270 PRINTTAB(33)"[illegible]"
6271 PRINTTAB(33)"[illegible]"
6275 PRINTTAB(33)"[illegible]"
6280 PRINTTAB(21)"[illegible]"TAB(33)"[illegible]"
6281 PRINTTAB(21)"[illegible]"
6285 GOSUB5300 GOSUB5310
6290 PRINTZD$"THIS IS THE TURBINE                 "Y"
6295 PRINT"[illegible]"TAB(17)"[illegible]"
6300 PRINTTAB(17)"[illegible]"
6305 PRINTTAB(17)"[illegible]"
6310 PRINTTAB(17)"[illegible]"
6315 GOSUB5300 GOSUB5310
6320 PRINTZD$"THIS IS THE ELECTRIC GENERATOR      "Y"
6325 PRINT"[illegible]"TAB(10)"[illegible]"
6330 PRINTTAB(10)"[illegible]"
6335 PRINTTAB(10)"[illegible]"
6340 PRINTTAB(10)"[illegible]"
6345 Z4=11 GOSUB5300 GOSUB5310
6350 PRINTZD$"THIS IS THE COOLING TOWER           "Y"
6355 PRINT"[illegible]"TAB(24)"[illegible]"TAB(31)"[illegible]"
6360 PRINTTAB(24)"[illegible]"TAB(30)"[illegible]"
6365 PRINTTAB(25)"[illegible]"TAB(29)"[illegible]"
6370 PRINTTAB(26)"[illegible]"TAB(29)"[illegible]"
6371 PRINTTAB(26)"[illegible]"TAB(29)"[illegible]"
6372 PRINTTAB(26)"[illegible]"TAB(29)"[illegible]"
6375 PRINTTAB(25)"[illegible]"TAB(29)"[illegible]"
6380 PRINTTAB(25)"[illegible]"
6385 GOSUB5300 GOSUB5310
6390 PRINTZD$"THIS IS THE COMPLETE DIAGRAM.       "Y"
6395 GOSUB5310 PRINT"[illegible]" POKE59468,14 RETURN
```


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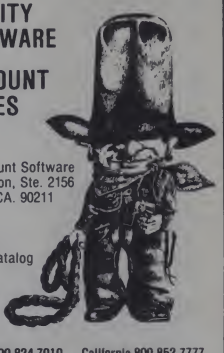

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Apple II

sensational software

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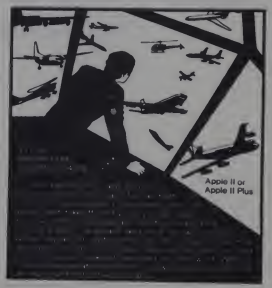
Air Traffic Controller



Action Games

Cassette CS-4017 $11.95 3 Games Requires 16K Apple II or Apple II Plus

Cycle Jump. Try to jump over rows of cars, buses and trucks

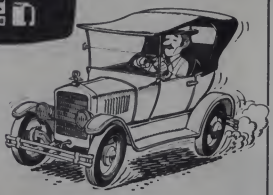
Mine Rover. Use your rover to cross a mine field with moving mines

Road Machine. Drive over a curving, mountain road as fast as possible. Eight skill levels

Milestones

Cassette CS-4015 $11.95 Requires 48K Applesoft or Apple II Plus

The object of Milestones is to complete a 700-mile auto trip before your opponent the computer. You must deal with hazards of the roads: stop lights, flat tires, speed limits, accidents and gas shortages. Spectacular high-resolution color graphics



Bumping Games

Cassette CS-4020 $11.95 3 Programs Requires 16K Apple II or Apple II Plus

Obstacle Course. This multi-level course includes hurdles, ladders, tires and penalty areas. Different every time

Hustle. The score keeps building but the escape routes dwindle. Can you reach the blocks before they disappear?

Bumper Blocks. An absorbing game of evasion and collision. Five skill levels.

Action & Bumping Games

Disk CS-4516, $24.95
Requires 32K Applesoft or Apple II Plus

The disk contains all six games from cassettes CS-4017 and CS-4020.

Milestones

Disk CS-4515, $19.95
Requires 48K Apple II or Apple II Plus

In addition to the game itself, this disk contains the complete playing instructions.

Advanced Air Traffic Controller

Disk CS-4517, $19.95
Requires 16K Apple or Apple II Plus

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CIRCLE 300 ON READER SERVICE CARD

Apple II sensational software

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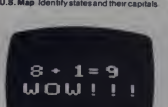
CAI Programs Vol I

Cassette CS-4201 $11.95

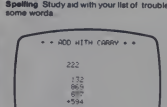
Requires 16K Apple II or Apple II Plus

U.S. Map Identify states and their capitals

Spelling Study aid with your list of troublesome words



Math Drill Arithmetic drill and practice with large or small display



Add With Carry Drill and practice on sums requiring numbers to be carried

Ecology Simulations - I

Disk CS-4706, $24.95

Requires 48K Applesoft in ROM or Apple II Plus

Sterl

STERL allows you to investigate the effectiveness of two different methods of pest control — the use of pesticides and the release of sterile males into a screw-worm fly population. The concept of a more environmentally sound approach versus traditional chemical methods is introduced. In addition, STERL demonstrates the effectiveness of an integrated approach over either alternative by itself.

Pop

The POP series of models examines three different methods of population projection, including exponential, S-shaped or logistical. Logistical with low density effects. At the same time the programs introduce the concept of successive refinement of a model, since each POP model adds more details than the previous one.

Tag

TAG simulates the tagging and recovery method that is used by scientists to estimate animal populations. You attempt to estimate the bass population in a warm-water, bass-bluegill farm pond. Tagged fish are released in the pond and samples are recovered at timed intervals. By presenting a detailed simulation of real sampling by tagging and recovery, TAG helps you to understand this process.

Buffalo

BUFFALO simulates the yearly cycle of buffalo population growth and decline, and allows you to investigate the effects of different herd management policies. Simulations such as BUFFALO allow you to explore what if questions and experiment with approaches that might be disstrous in real life.

CAI Programs Vol II

Cassette CS-4202 $11.95

Requires 16K Apple II or Apple II Plus

European Map Identify countries and their capitals

Meteor Math Learn math skills by destroying menacing meteors

Music Composing Aid Make and play your own music on the Apple. No additional hardware required. Includes a sample from Bach's Tocatta & Fugue in D minor.

Ecology Simulations - II

Disk CS-4707 $24.95

Requires 48K Applesoft in ROM or Apple II Plus

Pollute

POLLUTE focuses on one part of the water pollution problem, the accumulation of certain waste materials in waterways and their effect on dissolved oxygen levels in the water. You can use the computer to investigate the effects of different variables such as the body of water, temperature, and the rate of dumping waste material. Various types of primary and secondary waste treatment, as well as the impact of scientific and economic decisions can be examined.

Rats

In RATS, you play the role of a Health Department official devising an effective, practical plan to control rats. The plan may combine the use of sanitation and slow kill and quick kill poisons to eliminate a rat population. It is also possible to change the initial population size, growth rate, and whether the simulation will take place in an apartment building or an entire city.

Malaria

With MALARIA, you are a Health Official trying to control a malaria epidemic while taking into account financial considerations in setting up a program. The budget we use of field hospitals, drugs for the ill, three types of pesticides, and preventative medication, must be properly combined for an effective control program.

Diet

DIET is designed to explore the effect of four basic substances, protein, lipids, calories and carbohydrates, on your diet. You enter a list of the types and amounts of food eaten in a typical day, as well as your age, weight, sex, health and a physical activity factor. DIET is particularly valuable in indicating how a diet can be changed to raise or lower body weights and provide proper nutrition.

CAI Programs I and II

Disk CS-4701, $24.95
Requires 32K Integer Basic

This disk contains all 7 programs from cassettes CS-4201 and CS-4202.

Note: The ecology simulations programs are not available on cassette.

Stock & Options Analysis

Disk CS-4801, $99.95
Requires 32K Applesoft or Apple II Plus

This is a comprehenensive set of four programs for the investment strategy of hedging listed options against common stocks. A complete description is in the TRS-80 section. Available August 1981.

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CIRCLE 300 ON READER SERVICE CARD

Welcome to Stoneville Manor. This dream mansion can be yours, all yours, once you have obtained the deed. To get the deed, you need only open the safe. To open the safe you need only . . . . Well, we'll let you find that out for yourself. It will suffice to say that there are many surprises along the way.

Stoneville Manor is written in Applesoft, and requires 16K of *free* memory. Since this adventure might take some time to complete, a save-game feature is included which allows you to store the present status of the game on disk. To do this, give the command SAVE GAME. Whenever a new game is started, the combination of the safe changes. Good luck, and may all your deeds be legal.

Randy Jensen, 12501 Doons Dr., Oklahoma City, OK 73132.

Randy Jensen

```
10  HOME :L = 9
50  DIM I$(33),O$(33),O(33),L$(37
    ),D$(3,37),D(3,37)
100 VTAB (11): HTAB (12)
110 PRINT "STONEVILLE MANOR"
400 FOR X = 1 TO 33
410 READ I$(X),O$(X),O(X)
420 NEXT X
430 FOR X = 1 TO 37
440 READ L$(X)
450 NEXT X
460 FOR Y = 1 TO 37: FOR X = 1 TO
    3
470 READ D$(X,Y),D(X,Y)
480 NEXT X: NEXT Y
490 FOR X = 1 TO 3
500 READ P$(X)
510 NEXT X
520 FOR X = 1 TO 8
530 READ VE(X)
540 NEXT X
550 FOR X = 1 TO 3
560 Z =  INT (89 *  RND (1)) + 11
570 N#(X) =  STR$ (Z)
580 NEXT X
590 FOR X = 1 TO 3
600 Z =  INT (3 *  RND (1)) + 1
610 IF S(Z) = Z THEN 600
620 S$(Z) = N#(X):S(Z) = Z
625 NEXT X
630 HOME : VTAB (10)
640 PRINT  SPC( 15)"CREATED BY"
650 PRINT  SPC( 14)"RANDY JENSEN
    "
660 VTAB (22): HTAB (8)
670 INPUT "DO YOU WANT INSTRUCTI
    ONS?";I$
```

T/Maker II:™
it not only does more than VisiCalc,™ it does it on your computer.

VisiCalc is a fine aid for the computation of numerical problems. But it does have two major limitations: it is available only for a small number of systems, and its use is limited strictly to numbers, not words. To overcome these substantial limitations, Lifeboat Associates introduces T/Maker II.

Unlike VisiCalc, T/Maker II is designed to run on most small business computers with CP/M® or similar operating systems and a video terminal with cursor addressing capabilities. And soon there will be T/Maker II versions available for UNIX,™ RT-11™ and other systems.

Works with words as well as numbers. Like VisiCalc, T/Maker II reduces the manual tasks involved in computing and calculating financial documents. But since most business problems and reports involve words as well as numbers, T/Maker II also functions as a full-screen text editor for word processing.

T/Maker II is the most advanced aid for the analysis and presentation of numerical data and text material. In a matter of minutes, an entire document—including all edited text, all figures and all calculations—can be created, reviewed on your screen and reported in printed form.

T/Maker II turns your small business computer into a powerful, sophisticated and convenient tool. A tool that will save you money, time and energy, and eliminate the need for costly time-sharing.

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- Revenue and Expense Analyses
- Portfolio Evaluations
- Price Lists
- Rate Structures
- Expense Accounts
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- Checking Account Reconciliations

...and much, much more.

Easy to learn and use. You don't have to be a programmer to operate T/Maker II. Just follow T/Maker II's easily understood and ordered instructions, set up your data in rows and columns, define the relationships and T/Maker II will do the rest: it will perform the computations and formatting necessary to prepare your document. When you're finished you can analyze your report on your screen or store it on a diskette. Or, you can have the report printed with presentation quality.

And when any changes have to be made, simply enter the new figure or relationship and tell T/Maker II to adjust and recalculate all the new results.

Editing capabilities. As a full-screen editor for word processing, T/Maker II handles text up to 255 characters wide. It includes features like text formatting and justification, centered titles, a text buffer for block moves and repeated inserts, global search and replace commands for printing your letters, reports and documents. Wide documents are supported by horizontal scrolling.

Low cost. The cost of T/Maker II is only $275 plus shipping and handling. Dollars well spent once you consider all the time, energy and money it can save. T/Maker II is brought to you exclusively and supported completely by Lifeboat Associates, world's largest computer software publisher. For more information send us the coupon below.

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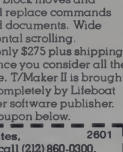

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As an example of what T/Maker II can do, see the chart below. The operator entered only the data shown in boldface. T/Maker II calculated and reported all the other values.

	— Actual —			Growth		Total	—Projected—		
	1978	1979	1980	Rate	Average	(000's)	1981	1982	1985
Item A	42,323	51,891	65,123	24.04	53,112	159.34	80,782	100,206	191,262
Item B	45,671	46,128	49,088	3.67	46,962	140.89	50,891	52,761	58,791
Total	87,994	98,019	114,211	13.93	100,075	300.22	131,673	152,966	250,053
% Item	48.10	52.94	57.02	8.88	52.69	158.1	61.35	65.51	76.49
% Item	51.90	47.06	42.98	9.00	47.31	141.9	38.65	34.49	23.51
Total	100.00	100.00	100.00		100.00	300.0	100.00	100.00	100.00

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CIRCLE 216 ON READER SERVICE CARD

```
680  IF  LEFT$ (C$,1) = "Y" THEN
     GOSUB 7500
700  HOME : VTAB (12): HTAB (2
710  INPUT "DO YOU WANT TO CONTIN
     UE AN OLD GAME?";C$
720  IF  LEFT$ (C$,1) = "Y" THEN
     GOSUB 8300
1000 HOME
1010 PRINT : INVERSE : PRINT "LO
     CATION:": NORMAL : PRINT L#(
     L)
1020 PRINT : INVERSE : PRINT "DI
     RECTION:": NORMAL
1030 FOR X = 1 TO 3
1040 GOSUB 5000
1050 NEXT X
1060 PRINT : INVERSE : PRINT "VI
     SABLE OBJECTS:": NORMAL
1070 IF L = 30 AND O(13) <  > 0 THEN
     1190
1075 IF L = 31 AND O(13) <  > 0 THEN
     1190
1085 FOR X = 1 TO 33
1090 IF O(X) = L THEN  PRINT O$(X)
1100 NEXT X
1110 GOSUB 5200
1190 PRINT : INPUT "NOW WHAT?";C
     $
1220 IF  LEFT$ (C$,3) = "GET" THEN
     2030
1225 IF C$ = "DROP SNORKEL" THEN
     3640
1230 IF  LEFT$ (C$,4) = "DROP" THEN
     2190
1240 IF  LEFT$ (C$,8) = "TAKE IN
     V" THEN 2350
1260 IF C$ = "ENTER VENT" THEN 2 395
1270 IF C$ = "ENTER BALLOON" THEN
     2540
1280 IF C$ = "ENTER LAKE" THEN 2
     600
1290 IF C$ = "ENTER DOOR" THEN 2
     650
1300 IF C$ = "ENTER STORE" THEN
     2680
1320 IF  LEFT$ (C$,5) = "ENTER" THEN
     2750
1340 IF  LEFT$ (C$,8) = "EXAMINE
     " THEN 2940
1350 IF  LEFT$ (C$,5) = "LOOK " THEN
     2880
1360 IF  LEFT$ (C$,6) = "GO JOG"
     THEN 3000
1370 IF  LEFT$ (C$,4) = "GO E" AND
     L = 32 THEN 3350
1380 IF  LEFT$ (C$,4) = "GO C" THEN
     3030
1390 IF  LEFT$ (C$,2) = "GO" THEN
     3080
1400 IF C$ = "PET SERVAL" THEN 3
     130
1410 IF C$ = "FEED SERVAL" THEN
     3150
1420 IF C$ = "GIVE TROUT" THEN 3
     170
1430 IF  LEFT$ (C$,8) = "CUT TRE
     E" THEN 3190
1435 IF  LEFT$ (C$,10) = "CLIMB
     TREE" THEN 3300
1440 IF  LEFT$ (C$,9) = "CHOP TR
     EE" THEN 3190
1450 IF  LEFT$ (C$,4) = "DIVE" THEN
     3210
1460 IF C$ = "END GAME" THEN  HOME
     : END
1470 IF  LEFT$ (C$,3) = "BUY" AND
     L = 10 THEN 2060
1475 IF C$ = "REMOVE COVER" THEN
     3250
1480 IF  LEFT$ (C$,3) = "OPEN VE
     NT" THEN 3250
1485 IF C$ = "OPEN BOOK" THEN 28
     50
1490 IF C$ = "OPEN DOOR" THEN 32
     95
1495 IF C$ = "OPEN CREDENZA" THEN
     2850
1500 IF C$ = "OPEN BAG" THEN 285
1510 IF C$ = "OPEN SAFE" THEN 70
     00
1520 IF C$ = "UNLOCK DOOR" THEN
     3295
1540 IF C$ = "INFLATE RAFT" THEN
     3350
1550 IF C$ = "INFLATE BALLOON" THEN
     3390
1560 IF C$ = "BUILD BALLOON" THEN
     3380
1570 IF C$ = "FLY BALLOON" THEN
     3460
1580 IF C$ = "SAIL BALLOON" THEN
     3460
1590 IF C$ = "READ WILL" AND F =
     1 THEN 7200
1600 IF C$ = "READ BOOK" THEN 28
     50
1605 IF C$ = "READ SIGN" THEN 33
     00
1610 IF C$ = "SAVE GAME" THEN 84
     00
1620 IF C$ = "CLEAR SCREEN" THEN
     1000
1990 PRINT "DON'T UNDERSTAND": GOTO
     1190
2030 IF C$ = "GET TROUT" AND L =
     29 AND O(10) <  > 0 THEN  PRINT
     "IT SLIPPED OUT OF YOUR HAND
     S": GOTO 1190
2035 IF C$ = "GET PICTURE" AND L
     = 16 THEN  PRINT "TO VALUABL
     E": GOTO 1190
2040 IF L = 10 THEN  PRINT "CAN
     ONLY BUY FROM STORE": GOTO 1
     190
2045 IF C$ = "GET TABLE" AND L =
     37 THEN  PRINT "IT'S NAILED
     DOWN": GOTO 1190
2050 IF S = 1 THEN 6000
2055 IF I = 4 THEN  PRINT "IT'S
     TOPY TO HEAVY": GOTO 1190
2060 IF C$ = "GET MASK" THEN 615
     0
2065 IF C$ = "GET SNORKEL" THEN
     6100
2070 FOR X = 1 TO 19
2080 G =  LEN (I$(X
2090 IF  MID$ (C$,5,6) = I$(X) AND
     O(X) = 0 THEN  PRINT "ALREAD
     Y HAVE OBJECT": GOTO 1190
2100 IF  MID$ (C$,5,6) = I$(X) AND
     O(X) = L THEN O(X) = 0: I = I
     + 1: GOTO 1000
2110 NEXT X
2120 IF C$ = "GET SERVAL" AND O
     (30) = L THEN 6200
2130 IF C$ = "GET CREDENZA" AND L
     = 14 THEN  PRINT "CAN'T LI
     FT IT": GOTO 1190
2140 IF C$ = "GET CASE" AND L <>
     I = L THEN  PRINT "NOT THER
     E": GOTO 1190
2150 IF C$ = "GET SAFE" AND O(3
     ) = L THEN  PRINT "SAFE IS S
     ECURED TO WALL": GOTO 1190
2170 GOTO 1990
2190 FOR X = 1 TO 19
2200 IF O(X) = L THEN (GET(X))
2210 IF  MID$ (C$,6,G) = I$(X) AND
     O(X) = 0 THEN 2240
2220 NEXT X
2230 GOTO 1990
2240 IF X = 8 AND L = 28 THEN O(
     8) = 51: I = I - 1: FLASH : PRINT
     "RAFT DRIFTS AWAY": FOR X =
     1 TO 3000: NEXT X: NORMAL : GOTO
     1000
2245 IF X = 8 AND L = 29 THEN O(
     8) = 51: I = I - 1: FLASH : PRINT
     "RAFT DRIFTS AWAY": FOR X =
     1 TO 3000: NEXT X: NORMAL : GOTO
     1000
2270 I = I - 1
2280 IF L = 28 THEN O(X) = 30: GOTO
     1000
2290 IF L = 29 THEN O(X) = 31: GOTO
     1000
2300 O(X) = L: GOTO 1000
2350 FOR X = 1 TO 19
2360 IF O(X) = 0 THEN  PRINT O$(
     X)
2370 NEXT X
2380 GOTO 1190
2395 FOR X = 1 TO 8
2400 IF V(X) = L THEN 2415
2405 NEXT X
2410 GOTO 1990
2415 IF O(8) = 0 AND R = 1 THEN
     PRINT P$(2): GOTO 1190
2420 FOR X = 1 TO 4
2430 IF O(X) = 0 THEN  PRINT P$(
     2): GOTO 1190
2430 NEXT X
2450 IF L = 13 AND C1 = 0 THEN PRINT
     P$(1): GOTO 1190
2460 IF L = 14 AND C2 = 0 THEN PRINT
     P$(1): GOTO 1190
2470 IF L = 17 AND C3 = 0 THEN PRINT
     P$(1): GOTO 1190
2480 IF L = 18 AND C4 = 0 THEN PRINT
     P$(1): GOTO 1190
2485 IF W = 0 THEN  PRINT "YOU W
     EIGH TO MUCH": GOTO 1190
2490 IF L = 13 AND C1 = 1 THEN L
     = 21: GOTO 1000
2500 IF L = 14 AND C2 = 1 THEN L
     = 24: GOTO 1000
2510 IF L = 17 AND C3 = 1 THEN L
     = 26: GOTO 1000
2520 IF L = 18 AND C4 = 1 THEN L
     = 27: GOTO 1000
2530 GOTO 1990
2540 IF H = 0 THEN  PRINT "NOT R
     EADY YET": GOTO 1190
2550 IF L = 8 THEN L = 34: GOTO
     1000
2560 IF L = 36 THEN L = 35: GOTO
     2570
2570 PRINT "CAN'T FIND": GOTO 11
     90
2600 IF L <  > 5 THEN 1990
2610 IF O(8) <  > 0 THEN  PRINT
     "NEED SOMETHING TO FLOAT ON"
     : GOTO 1190
2630 IF R = 0 THEN  PRINT "RAFT
     IS TO FLAT": GOTO 1190
2640 L = 28: GOTO 1000
2650 IF L = 16 AND K = 0 THEN  PRINT
     "DOOR IS LOCKED": GOTO 1190
2655 IF L = 20 THEN L = 16: K = 1
     : GOTO 1000
2660 IF L = 16 THEN L = 20: GOTO
     1000
2670 GOTO 1990
2680 IF L <  > 9 THEN  GOTO 1990
2690 FOR X = 1 TO 19
2700 IF O(X) = 0 THEN  PRINT "CA
     N'T ENTER STORE WITH INVENTO
     RY": GOTO 1190
2710 NEXT X
2720 L = 10: GOTO 1000
2750 IF C$ = "ENTER MANOR" AND L
     = 9 THEN L = 12: GOTO 1000
2760 IF C$ = "ENTER MANOR" AND L
     = 1 THEN L = 27: GOTO 1000
2770 IF C$ = "ENTER HOSPITAL" AND
     L = 9 THEN L = 11: GOTO 1000
2780 IF C$ = "ENTER TUNNEL" AND
     L = 31 AND O(13) = 0 THEN L =
     32: GOTO 1000
2790 IF C$ = "ENTER CREEK" AND L
     = 4 THEN  FLASH : PRINT "YO
     U SLIPPED AND FELL": FOR X =
     1 TO 3000: NEXT X: NORMAL : S
     = 1: L = 11: GOTO 1000
2800 IF C$ = "ENTER GORGE" AND L
     = 8 THEN  PRINT "TO STEEP":
     GOTO 1190
2810 IF C$ = "ENTER SHACK" AND L
     = 36 THEN L = 37: GOTO 1000
2820 GOTO 1990
2840 G =  LEN (C$) - 8: C$ =  MID$
     (C$,9,G): GOTO 2860
2850 G =  LEN (C$) - 5: C$ =  MID$
     (C$,6,G)
```

Lynn Busby, president of the Computer Station, as seen by the Dithertizer II.

You and your Apple can have a new view of the world.

Dithertizer!

Dithering. Developed at Bell Labs and MIT, dithering was originally an approach to picture transmission. Compared to other methods, dithering is fast and accurate.

The Dithertizer II was designed for the Apple computer by David K. Hudson, a researcher at MIT. Design goals were high accuracy, fast scanning, maximum reliability and an economical price.

High Quality Images

The resolution is of the Dithertizer is the maximum the Apple can handle in the high-resolution mode, i.e., 280 x 192 (53,760) pixels.

To produce an image, a video camera is focused on the subject. Peripherals Plus furnishes a Sanyo VC161OX camera, a laboratory/industrial unit with an f 1.6 lens. This camera has a focus range of 18" (for extreme close ups) to infinity (for distant subjects).

The camera scans an entire frame in 1/60th of a second. Two frames are scanned, of course, in 1/30th of a second. By adjusting the blackness control (with Paddle 0) to any one of 255 levels you can determine the threshold of gray between the two frames.

A 1/30th second, two-frame scan has two levels of gray and produces a high-contrast but quite recognizable image.

Pictures or Contours

Using the "Contour" software routines and contrast control (Paddle 1), it is possible to subtract one image from another. If the blackness thresholds of the two images are close, say 125 and 127, the resulting image will show just the outlines or highlights of an object.

Another possibility is to reduce the contrast to zero which results in a nearly blank screen except for movement in the area scanned. This type of movement detector is much faster (1/30th second) and more precise than other much more expensive systems. It is currently being used to detect and record movement of laboratory animals. It is also used in security installations.

The "Dithering" software routines use the contrast control to divide an image into gray tones. As mentioned above, two levels (usually white and black) result in a high contrast image. Four gray levels provide additional definition while sixteen levels produce a highly detailed image in just over 1/4th of a second. Extremely high detail is possible using the highest 64-gray level setting. At this level, an image is produced in 64/60ths of a second or just over one second. The quality of this image is close to that of a halftone photograph found in a newspaper or magazine.

Using Dithered Images

What can one do with a dithered image? Upon completion it can be stored automatically in either page 1 or 2 of the high-resolution graphics area of the Apple. Hence, it can be printed out on practically any printer. To print it on an Apple Silentype printer or equivalent requires no additional software.

To take advantage of the automatic print routines in the Dithertizer itself does require additional software tailored to a specific printer. Software packages are available at $44.95 each for the following printers: IDS 440, 445, 460, and 560; IP225; Anadex DP9500 and DP9501; Spinwriter 5510 and 5520.

Individual images or series of images may also be incorporated in other programs in the same way that other hi-res graphics are used. Using VersaWriter software, for example, text may be added to images. An image may be shown on the screen while a disk is loading or while the computer is completing a time-consuming calculation in another program.

With the proper software, the Dithertizer can be used to perform image enhancement, to identify features, detect motion, track a moving target or create a detailed picture for display. The possibilities are limited only by your imagination.

Quality Construction

The dithertizer is manufactured to exacting specifications by Computer Station. It consists of the Dithertizer II board which plugs into Slot 7 in the Apple II, a cable which connects between the Dithertizer and motherboard and a 10 foot cable to the camera. The system requires a 48K Apple disk system.

The software package consists of three routines on disk: "Dither" to build a gray scale picture, "Contour" to produce an edge scan using image subtraction, and "Dscan" to store a binary image in either page 1 or 2 of the high-resolution graphics area.

Peripherals Plus also includes a Sanyo VC161OX video camera with external horizontal and vertical sync input.

The components of the packge—hardware, software and camera—are warranteed by the manufacturers against defects in material and workmanship for 90 days. In addition, Peripherals Plus guarantees that if you are not completely satisfied you may return the system for a prompt and courteous refund

Order Today

The entire Dithertizer system consisting of the Dithertizer board, Sanyo camera, cables and software costs only $650 plus $6 shipping and handling in the continental United States. Customers in other loctions should write for shipping rates. Price for the board and software alone is $300 while the camera alone is $410. To order your system, send payment or Visa, MasterCard or American Express card number and expiration date to the adress below. Credit card customers may also call orders to our toll-free number.

Don't put it off. Remember, your system is backed by both manufacturer warranties and a complete moneyback guarantee of satisfaction from Peripherals Plus.

Give your Apple a new view of the world with a Dithertizer. Order today.

Peripherals Plus

39 East Hanover Avenue
Morris Plains, NJ 07950
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(In NJ 201-540-0445)

CIRCLE 239 ON READER SERVICE CARD

```
2860  FOR X = 1 TO 33
2870  IF O$ = I$(X) AND O(X) = L THEN
      2900
2875  IF O$ = I$(X) AND O(X) = 0 THEN
      2900
2880  NEXT X
2890  GOTO 1990
2900  IF O$ = "BOTTLE" THEN  PRINT
      P$(3):N#(1): GOTO 1190
2910  IF O$ = "GOBLET" THEN  PRINT
      P$(3):N#(2): GOTO 1190
2920  IF O$ = "TABLE" THEN  PRINT
      "ON TOP IS A NOTE WITH THE N
      UMBER "N#(3): GOTO 1190
2930  IF O$ = "CASE" THEN  PRINT
      "ONE BOTTLE IS MISSING": GOTO
      1190
2940  IF O$ = "BOOK" THEN 6550
2950  IF O$ = "CREDENZA" AND O(13
      ) = 40 THEN  PRINT "INSIDE I
      S A SWIM MASK": GOTO 1190
2960  IF O$ = "BAG" AND O(19) = 4
      0 THEN  PRINT "INSIDE IS A S
      NORKEL": GOTO 1190
2970  IF O$ = "PICTURE" THEN  PRINT
      "BEHIND PICTURE IS A SAFE":E
      = 1: GOTO 1190
2980  PRINT "NOTHING UNUSUAL": GOTO
      1190
3000  IF O(11) <  > 0 THEN  PRINT
      "NEED SHOES": GOTO 1190
3010  IF L  = 9 THEN  PRINT "CAN'T
      JOG HERE": GOTO 1190
3015  W = 1: PRINT "WHEW!...DONE":
      GOTO 1190
3020  IF L = 28 THEN L = 5: GOTO
      1000
3025  GOTO 1990
3030  IF S = 1 THEN  PRINT "NOT W
      ELL": GOTO 1190
3040  IF L = 21 AND C1 = 0 THEN PRINT
      P$(1): GOTO 1190
3050  IF L = 24 AND C2 = 0 THEN PRINT
      P$(1): GOTO 1190
3060  IF L = 26 AND C3 = 0 THEN PRINT
      P$(1): GOTO 1190
3070  IF L = 27 AND C4 = 0 THEN PRINT
      P$(1): GOTO 1190
3080  IF  LEFT$ (C$,4) = "GO E" AND
      L = 18 THEN 6300
3090  FOR X = 1 TO 3
3100  IF  MID$ (C$,4,1) = D$(X,L)
      THEN L = D(X,L): GOTO 1000
3110  NEXT X
3120  PRINT "DIRECTION NOT CLEAR"
      : GOTO 1190
3130  IF V = 0 AND L = 18 THEN 62
      00
3140  GOTO 1990
3150  IF V = 1 THEN 1990
3160  IF L  > 18 THEN 1990
3170  IF O(14) <  > 0 OR L  > 1
      8 THEN  PRINT "NEED FOOD": GOTO
      1190
3180  FLASH : PRINT "SERVAL TOOK
      TROUT AND ESCAPED": IF O(14)
      = 0 THEN I = I - 1
3185  V = 1: O(14) = 40: O(32) = 40:
      FOR X = 1 TO 3000: NEXT X: 
      NORMAL : GOTO 1000
3190  IF L = 2 AND O(12) = 0 OR O
      (12  = L THEN O(4) = 2: GOTO
      1000
3200  GOTO 1990
3210  IF L = 28 AND O(8) = 0 AND
      O(19) = 0 THEN O(8) = 51: L
      = 1: I=L = 30: FLASH : PRINT
      "RAFT DRIFTS AWAY": FOR X =
      1 TO 3000: NEXT X: NORMAL : GOTO
      1000
3215  IF L = 29 AND O(8) = 0 AND
      O(19) = 0 THEN O(8) = 51: L
      = 1: I=L = 31: FLASH : PRINT
      "RAFT DRIFTS AWAY": FOR X =
      1 TO 3000: NEXT X: NORMAL : GOTO
      1000
3220  IF L = 28 AND O(19) = 0 THEN
      L = 30: GOTO 1000
3225  IF L = 29 AND O(19) = 0 THEN
      L = 31: GOTO 1000
3230  IF L = 28 OR L = 29 THEN PRINT
      "NEED SNORKEL": GOTO 1190
3240  GOTO 1990
3250  IF L = 13 THEN C1 = 1: GOTO
      1000
3255  IF L = 21 THEN C1 = 1: GOTO
      1000
3260  IF L = 14 THEN C2 = 1: GOTO
      1000
3265  IF L = 24 THEN C2 = 1: GOTO
      1000
3270  IF L = 17 THEN C3 = 1: GOTO
      1000
3275  IF L = 26 THEN C3 = 1: GOTO
      1000
3280  IF L = 18 THEN C4 = 1: GOTO
      1000
3285  IF L = 27 THEN C4 = 1: GOTO
      1000
3290  GOTO 1990
3295  IF L = 16 OR L = 20 THEN 33
      05
3300  GOTO 1990
3305  IF L = 16 AND K = 0 THEN PRINT
      "CAN'T DOOR IS LOCKED FROM O
      THER SIDE": GOTO 1190
3310  PRINT "OK": GOTO 1190
3350  IF L  = 5 THEN  PRINT "NO
      T HERE": GOTO 1190
3360  IF R = 1 THEN  PRINT "ALREA
      DY INFLATED": GOTO 1190
3370  PRINT "OK":R = 1: GOTO 1190
3380  IF L  = 8 THEN  PRINT "NO
      T HERE": GOTO 1190
3390  FOR X = 1 TO 6
3395  IF O(X) = 0 OR O(X) = 8 THEN
      HE = HE + 1
3400  NEXT X
3405  IF HE = 6 THEN 3420
3410  PRINT "NOT READY":HE = 0: GOTO
      1190
3420  FOR X = 1 TO 6
3425  IF O(X) = 0 THEN I = I - 1
3430  O(X) = 40
3440  NEXT X
3450  H = 1: GOTO 1000
3460  IF H = 0 THEN  PRINT "NOT R
      EADY": GOTO 1190
3470  IF L = 8 OR L = 36 THEN PRINT
      "NEED TO GET IN FIRST": GOTO
      1190
3480  IF L = 34 THEN 3500
3485  IF L = 35 THEN 3570
3490  GOTO 1990
3500  Z = 13:Y = 5: GOSUB 6400
3510  Z = 01:Y = 11: GOSUB 6400
3520  Z = 3:Y = 17: GOSUB 6400
3530  Z = 8:Y = 23: GOSUB 6400
3540  Z = 13:Y = 29: GOSUB 6400
3550  HOME
3560  L = 35: GOTO 1000
3570  Z = 13:Y = 29: GOSUB 6400
3580  Z = 8:Y = 23: GOSUB 6400
3590  Z = 3:Y = 17: GOSUB 6400
3600  Z = 01:Y = 11: GOSUB 6400
3610  Z = 13:Y = 5: GOSUB 6400
3620  HOME
3630  L = 34: GOTO 1000
3640  IF O(19) <  > 0 THEN  PRINT
      "DON'T HAVE": GOTO 1190
3650  IF L  > 27 AND L  < 32 THEN PRINT
      "YOU QUICKLY GRAB IT BACK!":
      GOTO 1190
3660  O(19) = H: I = I - 1: GOTO 10
      00
3800  IF L  = 2 THEN 1990
3810  FLASH : PRINT "YOU FELL OFF
      ": FOR X = 1 TO 3000: NEXT X
      : NORMAL :S = 1:L = 11: GOTO
      1000
3900  IF O(9) = 0 OR O(9) = L THEN
      PRINT "SIGH SAYS:AN APPROPR
      IATE PLACE": GOTO 1190
3910  PRINT "CAN'T FIND": GOTO 11
      90
3950  IF O(19) = 0 THEN 3000
3960  PRINT "NEED SNORKEL": GOTO
      1190
5000  REM  DIRECTION
5010  IF D$(X,L) = "" THEN  RETURN
5020  IF D$(X,L) = "O" THEN  PRINT
      "OUT": RETURN
5030  IF D$(X,L) = "N" THEN  PRINT
      "NORTH": RETURN
5040  IF D$(X,L) = "E" THEN  PRINT
      "EAST": RETURN
5050  IF D$(X,L) = "S" THEN  PRINT
      "SOUTH": RETURN
5060  IF D$(X,L) = "W" THEN  PRINT
      "WEST": RETURN
5070  IF D$(X,L) = "U" THEN  PRINT
      "UP": RETURN
5080  IF D$(X,L) = "D" THEN  PRINT
      "DOWN": RETURN
5200  REM  OBJECTS
5210  IF O(13) = 0 AND L = 31 THEN
      PRINT "AN UNDERWATER TUNNEL
      ": RETURN
5220  IF L = 13 OR L = 14 OR L =
      17 OR L = 18 THEN  PRINT "VE
      NT"
5230  IF L = 13 AND C1 = 1 THEN PRINT
      "VENT COVER": RETURN
5240  IF L = 14 AND C2 = 1 THEN PRINT
      "VENT COVER": RETURN
5250  IF L = 17 AND C3 = 1 THEN PRINT
      "VENT COVER": RETURN
5260  IF L = 18 AND C4 = 1 THEN PRINT
      "VENT COVER": RETURN
5270  IF H = 1 AND L = 8 OR L = 3
      6 THEN  PRINT "HOT AIR BALLO
      ON": RETURN
5280  Z = INT (10 * RND (1)) + 1
5290  IF L = 6 AND Z = 1 THEN PRINT
      "THE BUTLER WITH TWO STICKS
      OF DYNAMITE": RETURN
5300  IF L = 3 AND Z = 3 THEN PRINT
      "THE MAID WITH A PACK OF BLO
      ODHOUNDS": RETURN
5310  IF L = 7 AND Z = 5 THEN  PRINT
      "THE GARDENER WITH A BULLDOZE
      R": RETURN
5320  IF L = 33 AND Z  = 5 THEN  PRINT
      "A BAT PASSES CLOSE BY": RETURN
5330  IF L = 27 AND Z  = 3 THEN PRINT
      "YOU HAVE COBWEB IN YOUR HAI
      R": RETURN
5340  IF L = 25 AND Z  = 3 THEN PRINT
      "A RODENT BRUSHES YOUR LEG":
      RETURN
5350  IF L = 4 AND Z = 7 THEN  PRINT
      "A TOWHEE JUMPS ACROSS THE CRE
      EK": RETURN
5360  IF L = 28 AND O(14) = 0 AND
      Z  = 3 THEN  PRINT "A HUNGRY
      GULL CIRCLES OVERHEAD": RETURN
5370  IF L = 2 AND Z = 5 THEN  PRINT
      "A PRIMATE WATCHES FROM ABOV
      E": RETURN
5390  RETURN
5800  IF Z = 7 THEN  "GET WELL": THEN S =
      0: PRINT "RECOVERED": GOTO 1
      190
6020  GOTO 1990
6100  IF O(19) = 0 THEN  PRINT "H
      LREADY HAVE OBJECT": GOTO 11
      90
6115  IF O(19) = 40 AND O(7) = 0 THEN
      O(19) = 0: I = I + 1: GOTO 10
      00
6120  IF O(19) = 40 AND O(7) = L THEN
      O(19) = 0: I = I + 1: GOTO 10
      00
6130  IF O(19) = L THEN O(19) = 0
      : I = I - 1: GOTO 1000
6140  GOTO 1990
6150  IF O(13) = 0 THEN  PRINT "H
      LREADY HAVE": GOTO 1190
6160  IF O(13) = 40 AND L = 14 THEN
      O(13) = 0: I = I + 1: GOTO 10
      00
6170  IF O(13) = L THEN O(13) = 0
      : I = I + 1: GOTO 1000
6180  GOTO 1990
```

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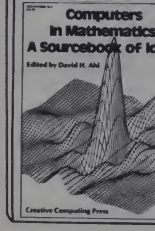
CIRCLE 164 ON READER SERVICE CARD

Sourcebook of Ideas

Many mathematics ideas can be better illustrated with a computer than with a text book.



Consider Baseball cards. If there are 50 cards in a set, how many packs of bubble gum must be purchased to obtain a complete set of players? Many students will guess over 1 million packs yet on average it's only 329.

The formula to solve this problem is not easy. The computer simulation is. Yet you as a teacher probably don't have time to devise programs to illustrate concepts like this.

Between grades 1 and 12 there are 142 mathematical concepts in which the computer can play an important role. Things like arithmetic practice, X-Y coordinates, proving geometric theorems, probability, compounding and computation of pi by inscribed polygons.

Endorsed by NCTM

The National Council of Teachers of Mathematics has strongly endorsed the use of computers in the classroom. Unfortunately most textbooks have not yet responded to this endorsement and do not include programs or computer teaching techniques. You probably don't have the time to develop all these ideas either. What to do?

For the past six years, *Creative Computing* magazine has been running two or three articles per issue written by math teachers. These are classroom proven, tested ideas complete with flowcharts, programs and sample runs.

Teachers have been ordering back issues with those applications for years. However, many of these issues are now sold out or in very short supply.

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This book contains pragmatic, ready to use, classroom tested ideas on everything from simply binary counting to advanced techniques like multiple regression analysis and differential equations.

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Another section presents over 250 problems, puzzles, and programming ideas, more than are found in most "problem collection" books.

Computers in Mathematics: A Sourcebook of Ideas is edited by David Ahl, one of the pioneers in computer education and the founder of *Creative Computing*.

The book is not cheap. It costs $15.95. However if you were to order just half of the back issues from which articles were drawn, they would cost you over $30.

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Stoneville Manor, continued...

```
6200  REM  SERVAL ATTACK
6210  FLASH : PRINT "YOU HAVE JUST
      ENOUGH STRENGTH TO GET AWAY
      ": FOR X = 1 TO 3000: NEXT X
      : NORMAL : S = 11: GOTO
      1000
6300  IF V = 0 THEN  PRINT "SERVA
      L WON'T LET YOU": GOTO 1140
6310 L = 19: GOTO 1000
6400  REM  BALLOON
6410  HOME : VTAB (Z)
6420  PRINT TAB( V)"-  -  -"
6425  PRINT  TAB( V - 1 "-        -"

6430  PRINT  TAB( Y - 2)"========
      ="
6440  PRINT  TAB( Y - 1)"-      -"

6445  PRINT  TAB( Y)"-   -"
6450  PRINT  TAB( Y + 1)"-"
6455  PRINT  TAB( Y + 1)" '"
6460  PRINT  TAB( Y + 1)"----"
6470  PRINT  TAB( Y + 1)"###"
6480  PRINT  TAB( Y + 1)"---"
6485  FOR X = 1 TO 1000: NEXT X
6490  RETURN
6500  FOR X = 1 TO 20: SO = PEEK
      ( - 16336): FOR Y = 1 TO 50:
      NEXT Y: NEXT X
6510  RETURN
6550  HOME
6560  PRINT : PRINT  TAB( 5)"HOW
      TO BUILD A HOT AIR BALLOON"
6570  PRINT : PRINT  TAB( 8)"#1 B
      ALLOON"
6575  PRINT  TAB( 8)"#2 HEAT SOUR
      CE"
6580  PRINT  TAB( 8)"#3 FUEL"
6585  PRINT  TAB( 8)"#4 GONDOLA O
      R CONTAINER"
6590  PRINT  TAB( 8)"#5 CABLE OR
      TWINE"
6595  PRINT  TAB( 8)"#6 MATCHES O
      R LIGHTER"
6600  PRINT "BUILD BALLOON AT AN
      APPROPRIATE PLACE"
6605  VTAB (22): HTAB (8)
6610  INPUT "PRESS RETURN TO CONT
      INUE ";C$
6620  GOTO 1000
7000  REM  SAFE
7010  IF E = 0 THEN  PRINT "CAN'T
      FIND": GOTO 1190
7030  IF L  >  16 THEN  PRINT "N
      OT HERE": GOTO 1190
7040  PRINT "COMBINATION LOCK"
7050  INPUT "ENTER FIRST NUMBER -
      -";F$(1)
7055  GOSUB 6500
7060  IF F$(1)  <  > S$(1) THEN  PRINT
      "NOT CORRECT": GOTO 1190
7070  INPUT "ENTER SECOND NUMBER
      --";F$(2)
7075  GOSUB 6500
7080  IF F$(1) + F$(2)  <  > S$(1)
      + S$(2) THEN  PRINT "NOT CO
      RRECT": GOTO 1190
7090  INPUT "ENTER LAST NUMBER --
      ";F$(3)
7095  GOSUB 6500
7100  IF F$(1) + F$(2) + F$(3)  <
      > S$(1) + S$(2) + S$(3) THEN
      PRINT "NOT CORRECT": GOTO 1
      190
7105 F = 1
7110  PRINT "CLICK'.............
      ...INSIDE IS A WILL": GOTO 1
      190
7200  HOME
7210  VTAB (6)
7220  PRINT " ******************
      ******************"
7225  PRINT " *": SPC( 36):"*"
7230  PRINT " *                WI
      LL                *"
7235  PRINT " *                *"
```

```
7240  PRINT " * I,MR. STONE,LEAVE
      ALL MY WORLDLY    *"
7245  PRINT " * POSSESSIONS TO WH
      OMEVER OPENS THIS *"
7250  PRINT " * SAFE.
                        *"
7255  PRINT " *"; SPC( 36);"*"
7260  PRINT " **********************
      **********"
7265  PRINT
7270  PRINT "                 CONGRATU
      LATIONS!!!": END
7500  HOME : PRINT
7510  PRINT "WELCOME TO STONEVILL
      E. YOU HAVE RECENTLY"
7520  PRINT "LEARNED THAT WEALTHY
      MR. STONE DIED AND"
7530  PRINT "RUMOR HAS IT THAT TH
      IS ECCENTRIC MILLIONAIRE"
7540  PRINT "HAS LEFT HIS ENTIRE
      ESTATE TO WHOMEVER"
7550  PRINT "FINDS AND OPENS HIS
      SAFE.": PRINT
7570  PRINT "TO PLAY,YOU MUST MAN
      IPULATE OBJECTS AND"
7580  PRINT "EXPLORE YOUR SURROUN
      DINGS BY USING TWO"
7590  PRINT "WORD COMMANDS.FOR EX
      AMPLE : 'GET BASKET'."
7600  PRINT "OR 'GO SOUTH'.TO SPE
      ED UP DIRECTIONAL"
7605  PRINT "MOVEMENT,'GO' COMMAN
      DS MAY BE SHORTENED"
7610  PRINT "TO INCLUDE ONE LETTE
      R SUCH AS 'GO S'.": PRINT
7615  PRINT "THE COMMAND 'SAVE GA
      ME' WILL PRESERVE"
7620  PRINT "YOUR PROGRESS FOR PL
      AY AT A LATER TIME".
7625  PRINT "OR IF YOU PREFER TO
      JUST END THE GAME"
7630  PRINT "THEN ENTER 'END GAME
      '.WHEN IF NEEDED."
7640  PRINT "CLEAR SCREEN' WILL
      RESET YOUR LOCATION."
7670  VTAB (22): HTAB (1)
7680  INPUT "PRESS RETURN TO CONT
      INUE";C$: RETURN
8000  DATA "BALLOON","FALLEN MEAT
      HER BALLOON",3,"POOR","SMAL
      L WOOD BURNING STOVE",1,"BAS
      KET","LARGE WICKER BASKET",1
      ,2
8010  DATA "LOGS","LOGS",40,"TWIN
      E","ROLL OF TWINE",17,"MATCH
      ES","BOOK OF MATCHES",15
8020  DATA "BAG","BURLAP BAG",16,
      "RAFT","INFLATABLE RAFT",1,"
      SIGN","SIGN",6
8030  DATA "NET","FISH NET",7,"SH
      OES","JOGGING SHOES",10,"AXE
      ","AXE",10
8040  DATA "MASK","SWIM MASK",40,
      "TROUT","TROUT",29,"GOBLET",
      "CRYSTAL GOBLET",19
8050  DATA "BOTTLE","EMPTY BOTTLE
      OF CHABLIS",33,"BOOK","BOOK
      ",14,"PICTURE","PICTURE OF M
      R. STONE"
8060  DATA "SNORKEL","SNORKEL",40
      ,"MANOR","STONEVILLE MANOR",
      9,"MANOR","STONEVILLE MANOR"
      ,1
8070  DATA "SHACK","OLD WEATHERED
      SHACK",36,"TABLE","WOODEN T
      ABLE",37,"CREDENZA","WALNUT
      CREDENZA",18
8080  DATA "SAFE","SAFE",40,"CHSE
      ","CASE OF CHABLIS",18,"TREE
      S","TREES",2
8090  DATA "DOOR","DOOR",20,"DOOR
      ","DOOR",16,"SERVAL","AN IMP
      ORTED SERVAL",18
8100  DATA "STORE","GENERAL STORE
      ",9,"STAIRWAY","STAIRWAY",13
      ,"HOSPITAL","HOSPITAL",9
8110  DATA "IN THE COURTYARD","IN
      A WOODED AREA","IN A MEADOW
      ","ALONG A SLIPPERY CREEK",
      "ON THE BANK OF A LAKE","IN A
       BARREN FIELD","ON A ROCKY T
      RAIL"
8120  DATA "AT THE EDGE OF A BORG
      E","GENERAL STREET","INTERSEC
      TION","HOSPITAL","IN THE COVER
      ","IN THE PARLOR"
8130  DATA "IN THE STUDY","IN AN
      OPIEL","IN THE GALLERY","IN
      THE ATRIUM","IN THE WEST WIN
      G OF THE MANOR","IN THE CELLAR","IN TH
      E EAST WING OF THE MANOR"
8140  DATA "AT THE OUTLET OF THE LA
      KE","AT A TURN IN THE DUCT","
      IN THE DUCT","AT THE DUCT","AT
       AN OUTLET IN THE DUCT","AT A
       TURN IN THE DUCT"
8150  DATA "AT AN OUTLET","IN THE D
      UCT","AT AN OUTLET IN THE DU
      CT","ON THE LAKE","IN THE SO
      UTHERN BAY","UNDER THE SURFA
      CE OF THE LAKE","UNDER THE S
      URFACE OF THE LAKE"
8160  DATA "ALONG AN UNDERGROUND
      RIVER","INSIDE A CAVERN","IN
       A HOT AIR BALLOON","IN A HO
      T AIR BALLOON","ON TOP OF A
      PLATEAU","INSIDE THE SHACK"
8170  DATA "W",2,"S",4,"",0,"E"
      ,1,"S",3,"W",9,"N",6,"E",4,"
      ",0,"W",3,"E",5,"N",1,"",4
      ,"",3,"",0,"E",3,"E",7,"",
      0,"W",6,"E",5,"",0
8180  DATA "W","",0,"",0,"S","
      E","NW",0,"",0,"",0,"",0,"
      ",0,"",3,"",0,"",0,"",3
      ,"S",13,"",3,"E","E",14,"
      S",12,"W",13,"E",15,"S",16
8190  DATA "W",14,"",0,"",0,"N"
      ,14,"W",17,"",0,"O",1,"N",1
      3,"E",16,"E",19,"",0,"",0,
      "W",18,"W",20,"",0,"D",19,"
      ",0,"",0,"O",13,"S",22,"",
      0,"N",21,"E",23,"",0
```

computer store of the month

The Program Store

The widespread use of computers in today's society has created numerous openings of computer stores over this country. *Creative Computing* would like to recognize one of these stores for their service and dedication to their customers and the computer industry. This month, we are spotlighting **The Program Store** in Washington, D.C.

While tourists flock to the national monuments, computer enthusiasts visiting Washington, D.C. have an additional stop: The Program Store. Customers delight to the assemblage of more than 1000 programs for TRS-80, Atari, and Apple computers; perhaps the largest selection of programs to be found anywhere.

Beginning as a mail-order outlet in 1978, the Washington store was opened a year later, followed by a Baltimore, MD location in late 1980. Computers are available to try out the programs before purchasing them, and the stores additionally carry Atari computers and a selection of hardware peripherals for popular microcomputers.

"We are a people-oriented store, where our customers feel at home" says president Ray Daly. Perhaps this attitude is the reason for the demand for more Program Stores. Vice president Janine Perky says, "We have recently begun franchising operations in order to fill the needs of other cities for our kind of stores."

The Program Store has locations at the Tenly Mall, 4200 Wisconsin Avenue, N.W., Washington, D.C. 20016, and W. Bell Plaza, 6600 Security Blvd., Baltimore, MD 21207. The store's toll-free phone number is 800-424-2738.

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Creative Computing is the leading magazine of small computer applications and software. It has in-depth reviews of new systems, peripherals and software. Also articles for both beginners and experts; columns about popular computers, programming techniques and new products; and complete program listings for your computer.

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How to Solve It
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Reading Level
25 Fantastic New Products from the Consumer Electronics Show

Stoneville Manor, continued...

```
8200  DATA  "W",22,"N",24,"S",25,
      "O",14,"S",23,"-",0,"N",23,"
      W",26,"-",0,"O",17,"D",27,"E
      ",25,"O",18,"U",26,"-",0,"O"
      ,5,"S",29,"-",0,"N",28,"-",0
      ,"-",0
8210  DATA  "U",28,"S",31,"-",0,"
      U",29,"N",30,"-",0,"E",31,"W
      ",33,"-",0,"E",32,"-",0,"-",
      0,"O",8,"-",0,"-",0,"O",36,"
      -",0,"-",0,"-",0,"-",0,"-",0
      ,"O",36,"-",0,"-",0
```

```
8220  DATA "VENT IS COVERED","SOM
      ETHING IS TO BIG","INSIDE IS
      A NOTE WITH THE NUMBER "
8230  DATA  13,14,17,18,21,24,26,
      27
8300  REM  RETPIEVE
8310  D$ =  CHR$ (4)
8320  PRINT D$;"OPEN GAME"
8330  PRINT D$;"READ GAME"
8340  INPUT L,W,S,I,F,H,R,K,E,V
8350  INPUT C1,C2,C3,C4
8360  INPUT N$(1),N$(2),N$(3),S$(
      1),S$(2),S$(3)
8370  FOR X = 1 TO 3
8380  INPUT O(X)
8390  NEXT X
8395  PRINT D$;"CLOSE  GAME": RETURN

8400  REM  SAVE
8410  D$ =  CHR$ (4)
8420  PRINT D$;"OPEN GAME"
8430  PRINT D$;"WRITE GAME"
8435  PRINT L; PRINT W; PRINT S; PRINT
      I; PRINT F
8440  PRINT H; PRINT R; PRINT K; PRINT
      E; PRINT V
8445  PRINT C1; PRINT C2; PRINT C
      3; PRINT C4
```

```
8450  PRINT N$(1); PRINT N$(2); PRINT
      N$(3)
8460  PRINT S$(1); PRINT S$(2); PRINT
      S$(3)
8470  FOR  = 1 TO 33
8480  PRINT O(X)
8490  NEXT X
8495  PRINT D$;"CLOSE GAME"
8500  HOME : END
```

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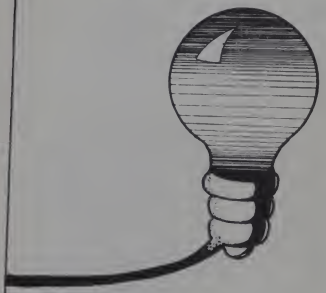

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TERMINALS & I/O

12-VOLT PRINTER

Syntest Corporation announces the SP-314 dot matrix alphanumeric printer which features 12-volt D.C. operation allowing complete independence from power lines.

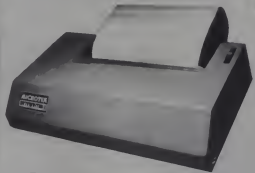
Other features of the SP-314 include: buffered 40-column impact printing, RS-232 serial and parallel inputs, crystal controlled baud rate, 96-character ASCII set plus double width, and a self test routine. In addition, the unit includes graphics capabilities for special printer applications. $605.

Syntest, 169 Millham St., Marlboro, MA 01752. (617) 481-7827.

CIRCLE 351 ON READER SERVICE CARD

80-COLUMN PRINTER

Microtek, Inc. announces an 80-column dot matrix printer, the Bytewriter-1. The printer accepts single sheet or roll paper up to 8 1/2" wide and prints at 60 lines per minute using a 7 x 7 dot matrix.



The Bytewriter-1 interface is similar to a Centronics parallel interface, and has been designed specifically to operate with the Apple II, the Atari 400/800, and all models of the TRS-80. $299.

Microtek, Inc., 9514 Chesapeake Dr., San Diego, CA 92123. (714) 278-0633.

CIRCLE 352 ON READER SERVICE CARD

MEMORY

16K RAM CARD FOR APPLE

Computer Stop has announced the CS16K RAM Card to increase Apple II memory. With 48K bytes of RAM already in place, the card increases capacity to 64K.

The Card is compatible with Pascal, CP/M, DOS 3.3, Cobol, Fortran, VisiCalc, Pilot, Integer Basic, Applesoft Basic and other software currently used with Apple II. $195.

Computer Stop, 2545 W. 237th St., Suite L, Torrance, CA 90505. (213) 539-7670.

CIRCLE 353 ON READER SERVICE CARD

MEMORY SYSTEM FOR ATARI 800

Axlon Incorporated has introduced the Axlon 256 memory system, which increases the storage capacity of the Atari 800 computer from 48K to 256K of RAM.

The product functions as a very fast disk. It is plug compatible with the Atari 800.

The system comes with two 32K RAM-CRAM modules and additional modules can be added until the full 256K capacity

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CIRCLE 228 ON READER SERVICE CARD

New Products, continued...

is achieved. Atari RAM modules can also be used in the Axlon system.

The standard system, with 64K of RAM, has a suggested retail price of $895.

Axlon Inc., 170 N. Wolfe Rd., Sunnyvale, CA 94086. (408) 730-0216.

CIRCLE 354 ON READER SERVICE CARD

PERIPHERALS

UPGRADE FOR ATARI VCS

Computer Magic, Inc. announces the MagiCard, a plug-in module for the Atari Video Computer System. The MagiCard is said to allow Atari VCS owners with keyboard controllers to upgrade the game to a self-contained computer.

The MagiCard contains 1K bytes of RAM and a 2K byte ROM monitor whose capabilities include commands for examining and depositing into memory, disassembling 6502 microprocessor programs, and running user-written programs. Monitor subroutines to display text or memory-mapped color graphics on a TV screen are accessible to the user. $49.88.

Computer Magic, Inc., P.O. Box 3383P, Fox Valley Center, Aurora, IL 60505.

CIRCLE 355 ON READER SERVICE CARD

DIRECT-CONNECT MODEM FOR APPLE

A direct-connect telephone modem for use with Apple II and Apple II Plus microcomputers has been introduced by ESI Lynx.

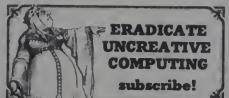
Standard features include originate/answer, programmable word length, parity, number of stop bits, and full/half duplex. Optional at extra cost are auto-dial and auto-answer functions. $289.95.

ESI Lynx, 123 Locust St., Lancaster, PA 17602. (717) 291-1116.

CIRCLE 356 ON READER SERVICE CARD

PERCUSSION SYNTHESIZER

The Rhythm Box is a peripheral that synthesizes the sounds of seven different percussion instruments including bass drum, wood block, snare drum, short cymbals, long cymbals, hand-clap, and tom-tom. It is programmed in Level II Basic or assembly language; a single instruction generates any combination of



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- Switchable single density (FM) or double density (MFM)
- Automatic head load
- Automatic head unload after 2 seconds
- Switchable 1 or 2 sided operation
- Switchable 40 track/80 track
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- Switchable 35 track/40 track
- Switchable 10 sector/16 sector
- Automatic write precompensation
- Automatic write current reduction
- Automatic write protect
- Automatic write protect disable
- Automatic write protect disable
- Automatic write protect disable

New Products, continued...

percussion sounds plus a loudness control for rhythmic emphasis.

The Rhythm Box is available with two interface options: Model RBX-T ($149) for the Model I Level II TRS-80 has a 40-pin ribbon cable that plugs into the keyboard or EI bus extension connector. The Model RBX-S ($179) is for use on all other computers (S-100, PET, Apple, etc.), and connects with two wires to any standard 9600 baud serial interface using either RS-232 or 20ma current loop levels.

Newtech Computer Systems, Inc., 230 Clinton St., Brooklyn, NY 11201. (212) 625-6220.

CIRCLE 357 ON READER SERVICE CARD

TEKTRONIX EMULATOR FOR S-100

A graphics interface and software package available from Cambridge Development laboratory enables S-100 computers to emulate a Tektronix 4010 series terminal. The Raster Scan Tektronix Emulator provides excellent resolution (640 x 512) raster graphics in black and white, gray tones, or color. All hardware is S-100 bus compatible.

"Ne'er look for the birds of this year in the nests of the last."

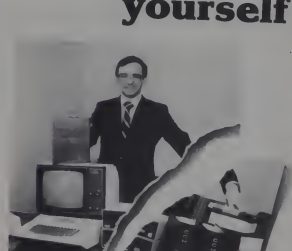
Cervantes

Software is CP/M compatible, offering an unlimited number of character sets, selective erase, and color selection. Compatible monitors, light pen, and graphical Basic are available as other hardware options.

Cambridge Development Laboratory, 36 Pleasant St., Watertown, MA 02172.

CIRCLE 358 ON READER SERVICE CARD

do you have a hard time tearing yourself away...



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For hard disk users — PAYROLL "HD" has a capacity of 745 employees and 63 Divisions, plus other special features, and requires a Pascal language card system.

Apple II is a trademark of Apple Computer Company.

Brøderbund Software Box 3266, Eugene, Oregon 97403 (503) 343-9024

CIRCLE 129 ON READER SERVICE CARD

DIRECT/ACOUSTICALLY COUPLED MODEM

Lexicon Corporation announces a 300 bps modem, the LEX-12, for the personal computer and terminal markets.

The LEX-12 allows direct coupling at the telephone handset jack, direct coupling to the phone line or acoustic coupling thru the telephone handset.

The 300 baud director acoustically coupled, full-duplex modem has originate or answer capability switch selectable. The RS-232 interface of the LEX-12 makes it compatible with most terminals, and small computers. $199.

Lexicon Corporation, 8355 Executive Center Dr., Miami, FL 33166.

CIRCLE 359 ON READER SERVICE CARD

DIRECT CONNECT MODEM

Bizcomp Corporation introduces the Model 1084 Intelligent VersaModem, specifically designed for use with Apple, Radio Shack, Commodore, Atari and many other computers.

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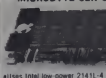

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•Low power consumption 800mA
•Fully warrantied for 120 days from date of shipment

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asap's atari 800
Computer System
16K RAM MODULE
$799.95
1 YEAR WARRANTY
PARTS AND LABOR

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(MONITORS)

MODEL	SIZE	PRICE
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VM906	9'' B&W	$265.00
VM129	12'' B&W	$340.00
VM17	17'' B&W	$360.00
CM13L	13' Color	$375.00

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•Optional Interfaces Available

THE EPSON MX-80
80 COLUMN DOT MATRIX PRINTERS

SPECIFICATIONS
Print method: serial impact dot matrix
Print rate: 80 CPS
Print mode: bi-directional
Number of print columns: 8
Matrix: 9 x 9
Line spacing: 1/6", 1/8", 7/72", + programmable
Line feed rate: 4.23 LPS (1/6" line spacing) 5.64 LPS (1/8" line spacing) 16.9 LPS @ 240 line/sec
Life: 10 million characters

PRINTING CHARACTERISTICS
Character Set: Full 96 char. ASCII with descenders
Graphics Characters: 64 blank characters

INTERFACE
Standard: Centronics style 8-bit parallel
Optional: RS232 / 20mA
Buffer Size: 1 line

AMPEX
DIALOGUE 80
CRT VIDEO TERMINAL

Reg. Price
$995.00
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$945.00

Console has non-glare 12-inch diagonal display screen. Brightness control enhances clarity. Detached typewriter style keyboard designed for optimum operator comfort and usability.

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CRT/TERMINALS

MODEL #	PRICE
TVI 912B	$ 749.00
TVI 912C	$ 769.00
TVI 920B	$ 825.00
TVI 920C	$ 825.00
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•Fast—3 ms Track to Track
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California Computer Systems

SPECIFICATIONS
The Model 7728 maintains high speed (1usec/word) byte throughput via direct memory access and interrupt logic. Interrupt logic can be used with or without DMA. Board occupies one 16BD card slot and requires +5V @ 1.5A max. and +12V @ 100mA max. Comes complete with 2716 EPROM containing firmware for polled operation. Interrupt logic is jumper selectable for any of eight priority levels. The 7728 is fully compatible with the 7720 and 7721 parallel interfaces. Other models are available with serial interfaces, synchronous and asynchronous, with RS232 or 20mA current loop. Contact factory for information.

MODEL 7728A
CENTRONICS PRINTER INTERFACE FOR APPLE II

$95.00
*Optional cables available

4116's
(200 NS.)
Apple, TRS-80, Heath etc.
8 for $20.00

16-49	$2.35
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100 Up	$2.15

2114L-2
(200 ns) Low-Power
STATIC RAM

1-16	$3.05
17-49	$2.95
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New Products, continued...

The VersaModem allows automatic dialing and auto-answer capability controlled through an RS-232 interface. Its Code-Multiplexed Design allows dialing functions to be implemented in high level languages such as Basic or Cobol. $299.

Bizcomp Corporation, P.O. Box 7498, Menlo Park, CA 94025. (415) 966-1545.

CIRCLE 360 ON READER SERVICE CARD

DISK & TAPE SYSTEMS

DOUBLE DENSITY DISK CONTROLLER FOR HEATH/ZENITH 89

Magnolia Microsystems has released a double density disk controller for the Heath/Zenith 89 computer which supports up to four 8" disk drives and four 5" disk drives. These supplement the three 5" drives supported by the existing Heath/Zenith controller.

A 5" double-sided, 96 TPI drive holds up to 700 KBytes, while an 8" double-sided drive holds over 1.2 MBytes. Four of each gives the 89 user on-line access to 7.6 MBytes of information with the interchangeability of floppies. $595.

Magnolia Microsystems, Inc., 2812 Thorndyke Ave. West, Seattle, WA 98199. (206) 285-7266 or (800) 426-2841.

CIRCLE 361 ON READER SERVICE CARD

BOOKS AND BOOKLETS

SOURCE BOOK FOR HEATH/ZENITH

The Information Center announces The Information Center Sourcebook, a buyer's guide for users of Heath/Zenith computer systems.

The Sourcebook features separate sections for hardware, software, printed matter, and business applications software, as well as listings of dealers and service centers. $20.

The Information Center, 642-A West Rhapsody, San Antonio, TX 78216. (512) 340-1561.

SOFTWARE BUYER'S GUIDE

Lifeboat Associates had released a buyer's guide and catalog. The 35-page catalog lists over 50 media formats. CP/M compatible disk operating systems, hard disk integration modules, system tools, telecommunications, languages, language and application tools, word processing systems and aids. Also listed are data management systems, general purpose applications, mail list systems, financial accounting packages, numerical problem-solving tools, professional and office aids, and books, periodicals and accessories.

Catalog Department, Lifeboat Associates, 1651 Third Ave., New York, NY 10018. (212) 860-0300.

BASIC AND FORTRAN COURSES

Heathkit/Zenith Educational Systems announces two computer programming courses, the EC-1101 Fortran Programming Course and the EC-1110 Microsoft Basic programming course.

The Fortran course teaches the fundamentals of programming in Fortran, with a 500-page text and six cassette tapes. $99.95.

The Microsoft Basic course features a 500-page text and three audio cassettes which teach the user how to get the most out of MBasic. $99.95.

Heathkit/Zenith Educational Systems. Dept. 350-055. Benton Harbor, MI 49022.

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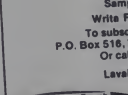
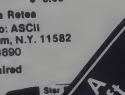


*TRS-80 is a product of Tandy Corp.



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WHAT IS LIST N LOAD® ?

LIST N LOAD ® is a Disk Based Utility program that enables you to SELECT and RUN any program on YOUR disk merely by depressing a "KEY".

HERE'S THE PROOF: YOU COUNT THE STEPS AND IMAGINE ALL THE TIME YOU'LL SAVE LOCATING AND EXECUTING YOUR PROGRAMS.

PRESENT METHOD	LIST N LOAD® METHOD
1 BOOT DISC WITH DOS	1 BOOT DISK WITH DOS
2 TYPE DOS	2 SELECT PROGRAM
3 DEPRESS RETURN	3 DEPRESS START
4 ENTER A	
5 DEPRESS RETURN	
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CIRCLE 177 ON READER SERVICE CARD

SYSTEMS SOFTWARE

LANGUAGES

Texas Instruments has announced *TI Logo*, a computer language designed to help students in primary grades through high school develop problem-solving skills. In addition to the software, the complete Logo system requires a standard TI 99/4 equipped with monitor, disk drive, disk controller and memory expansion unit. $299.95. Texas Instruments, P.O. Box 53, Lubbock, TX 79408.

CIRCLE 365 ON READER SERVICE CARD

Vigil is an interactive graphics and game language for PET/CBM computers. Features include: more than 60 commands to manipulate graphics features on the screen, double density graphics which provides 80 x 50 positions on 40-column machines, and access to two event timers. $35. Abacus Software, P.O. Box 7211, Grand Rapids, MI 49510.

CIRCLE 366 ON READER SERVICE CARD

SYSTEMS

Comal is a structured language said to be similar to Pascal, but easier to learn. An information packet available free of charge to PET/CBM users contains information on user groups, books, articles and software. It also provides instructions on obtaining a free Comal compiler. The Comal Users' Group, 5501 Groveland Ter., Madison, VT 53716.

Computerware introduces a **Color Editor** on cassette for the Radio Shack Color Computer. It allows use of upper and lower case as well as change and search commands. $24.95. Also available is **Color Assembler**, a 6809 machine code assembler which supports all 6809 mnemonics and addressing modes along with standard assembler options and directives for the Color Computer. $29.95. Both programs require the power pack. Computerware, Box 668, 1512 Encinitas Blvd., Encinitas, CA 92024. (714) 436-3512.

CIRCLE 367 ON READER SERVICE CARD

The Software Toolworks announces a group of programming languages and other software tools for use on CP/M systems. They include: the **C/80 C Compiler** which implements a subset of the C programming language; **Lisp/80**, an 8080 implementation of an artificial intelligence language; the **RATFOR** preprocessor which provides structured programming constructs for Microsoft Fortran; a **text formatter**; and Z-80 and 8080 opcode versions of the UVMAC macro assembler. Prices range from $20 to $40. The Software Toolworks, 14478 Glorietta Dr., Sherman Oaks, CA 91423. (213) 986-4558.

CIRCLE 368 ON READER SERVICE CARD

Mince is a video text editor for use on CP/M systems. It is written in C and offers upward compatibility from 8080 and Z-80 microcomputers to 16-bit computers. $125. Westico, Inc., 25 Van Zant St., Norwalk, CT 06855. (203) 853-6880.

CIRCLE 369 ON READER SERVICE CARD

DATA BASE MANAGEMENT SYSTEMS

C.O.R.P. database management system is a program generator that allows the user to write data-base management systems in Applesoft Basic. The system requires an Apple II Plus or Apple II with at least 48K of memory, two disk drives (DOS 3.3), auto-start ROM and Applesoft in ROM. $189.95. Maromaty and Scotto Software Corp., P.O. Box 610, Floral Park, NY 11001.

CIRCLE 370 ON READER SERVICE CARD

The **Express** option for the Oasis operating system combines the capabilities of an English-like inquiry language and an advanced program generator in a multi-user relational database management system. The program uses "free-form" sentences to compare, manipulate and report information from multiple files. $695. Phase One Systems, 7700 Edgewater Dr., Suite 830, Oakland, CA 94621. (415) 562-8085.

CIRCLE 371 ON READER SERVICE CARD

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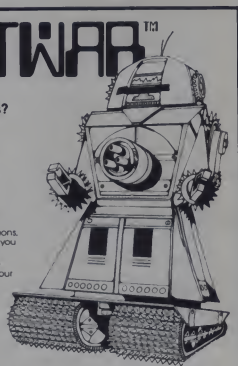

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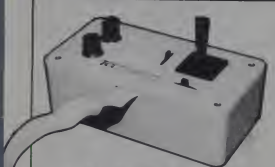
CIRCLE 225 ON READER SERVICE CARD

Why would anyone spend $59.95 for a joystick?



Super Joystick

Star Wars. Played with paddles, it's difficult at best and frustrating at worst. But with a joystick it becomes an entirely new experience. It's still challenging. It's also fun. And very addictive.

Have you ever used a drawing program in which one paddle controls the horizontal movement of the "brush" and the other paddle the vertical? It's slow, tedious work. But with a joystick, drawing is an absolute joy.

Exceptional Precision

The Apple high-resolution screen is divided into a matrix of 160 by 280 pixels. To do precise work on this screen, you need a precise device. Most potentiometers used in paddle controls are not quite linear. If you rotate a paddle control at a constant speed, you'll notice that the cursor speeds up slightly at the beginning and end of the paddle rotation.

The Super Joystick has a pure resistive circuit which is absolutely linear within one tenth of one percent. In other words it would give you precise control over an image of 1000 by 1000 pixels, were such resolution available. Thus it is suitable for high precision professional applications as well as educational and hobbyist ones.

Matched to your application

The Super Joystick also has two external trim adjustments, one for each direction. This allows you to perfectly match the unit to your application and computer. Say you want to work in a square area instead of the rectangular screen. Just reduce the horizontal size with the trim control.

How many times have you played Space Invader and had your thumb ache for hours from the repeated button pressing? This won't happen with the Super Joystick. It's two pushbuttons are big. Moreover, they use massive contact surfaces with a life of well over 1,000,000 contacts. A few games of Super Invader using these big buttons will justify the purchase of the Super Joystick.

The Super Joystick is self-centering in both directions. That means when you take your hand off it, the control will return to the center. However, if you want it to stay where you leave it, self-centering may be easily disabled.

The Super Joystick plugs right into the paddle control socket and doesn't require an I/O slot.

High-quality construction

The sturdy metal case of the Super Joystick matches that of the Apple computer. Every component used is the very highest quality available. The Super Joystick even uses a full 16-conductor ribbon cable so you can add a second joystick if you wish. The first Super Joystick replaces Paddles 0 and 1. You may not realize it, but the Apple can support four paddle controls. A second Super Joystick would replace Paddles 2 and 3.

By removing two springs, self-centering can be defeated.

We invite your comparison of the Super Joystick with any other unit available. Order it and use it for 30 days. If you're not completely satisfied, return it for a prompt and courteous refund plus your return postage. You can't lose.

The Super Joystick consists of a self-centering, linear joystick, two trim controls, and two pushbuttons mounted in an attractive case. It comes complete with an instruction booklet and 90-day limited warranty. Cost is $59.95.

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CIRCLE 239 ON READER SERVICE CARD

New Products, continued...

Info80 is a filing and information management system designed to run on the TRS-80 Models I and III with 48K and disk drives. The system supports continuously variable record input length and automatically creates and extends disk files. $100 on data diskette; $115 on TRSDOS diskette. Bluebird's Computer Software, 2267 23rd St., Wyandotte, MI 48192. (313) 285-4455.

CIRCLE 372 ON READER SERVICE CARD

APPLICATIONS SOFTWARE

GAMES AND RECREATIONAL

Manhattan Software announces four programs for the Atari Personal Computer: **Gin Rummy**, which requires 32K of memory and one joystick ($19.95); **Casino Blackjack/Counter** for 24K and one joystick ($19.95); **Labyrinth Run** in which the player uses the joystick to guide a fast-moving runner through twisting course ($14.95); and **Concentration**, a two-player version of the match-the-card game, which requires 16K or 24K and two joysticks ($14.95). Manhattan Software, P.O. Box 35, Pacific Palisades, CA 90272. (213) 454-8290.

CIRCLE 373 ON READER SERVICE CARD

Automated Simulations has released three EPYX games for the 32K Atari 800. In **Invasion Orion**, a tactical space battle game, the player controls up to nine space ships armed with destructor beams, tractor beams, missiles and torpedos, against the computer ($24.95). In the **Datestones of Ryn**, the player must recover the stolen Datestones of the ducal calendar from within a maze ($19.95). **Rescue at Rigel** is a science fiction, role-playing game in which the player has 60 minutes to find 10 humans held captive inside an alien moonbase ($29.95). Automated Simulations, Inc., P.O. Box 4247, Mountain View, CA 94040.

CIRCLE 374 ON READER SERVICE CARD

Cribbage for the TRS-80 Models I and III is written in Basic with machine language patches. It will work on Level I, II or DOS systems. $16.95 on cassette; $19.95 on disk. The Alternate Source, 1806 Ada St., Lansing, MI 48910. (517) 487-3358.

CIRCLE 375 ON READER SERVICE CARD

Space Raiders is an animated, machine language, graphics program designed to rival popular arcade style games. There are five levels of simulation and every game is different. The program runs on the 16K Level II TRS-80 Model I. $24.95.

Bosen Electronics, 445 East 800 North, Spanish Fork, Utah 84660. (801) 798-9553.

CIRCLE 376 ON READER SERVICE CARD

EDUCATION

Classfile is a classroom record-keeping program for the 16K TRS-80 Models I and III. The program allows the teacher to produce: a list of all students in a class and their grades, a list of all students whose grade falls below a cut-off point, a list of all students and averages in rank order by average, the class average or the average of any student by name. $19.95. TYC Software, 40 Stuyvesant Manor, Geneseo, NY 14454. (716) 243-3005.

CIRCLE 377 ON READER SERVICE CARD

Edu-Ware Services announces a new product line, **Interactive Fantasies**, which includes The Prisoner, Terrorist, Windfall, Network, Space and Space II. Also available is **Perception Version 3.0** which includes seven programs to challenge the user's visual judgment and sharpen his eye-hand coordination. Edu-Ware Services, Inc., 22222 Sherman Way, Ste. 102, Canoga Park, CA 91303. (213) 346-6783.

CIRCLE 378 ON READER SERVICE CARD

BUSINESS

Long Distance Analyzer is a business program for the TRS-80. The program matches a phone bill with a file of recognized numbers; calls are grouped and totalled by number to help in cost accounting, billing clients, and investigating unfamiliar numbers. Usage patterns are analyzed by area code, state and WATS zone. Cassette version for Models I and II, $95; disk version, $135; Model II disk, $155. Golden Braid Software, P.O. Box 2934, Sarasota, FL 33578.

CIRCLE 379 ON READER SERVICE CARD

Cybersoft announces Version 5.0 of **Medical Billing System**. Written in CBasic-2 for CP/M-based systems, the package consists of 21 menu-driven programs for operating a medical practice. Cybersoft, 433 Valley Ave., Birmingham, AL 35209. (205) 942-8567.

CIRCLE 380 ON READER SERVICE CARD

Charles Mann & Associates has introduced **Payroll 1** for the TI 99/4. The system allows a small business with fewer than 100 employees to operate a weekly, bi-

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New Products, continued...

weekly, semi-monthly or monthly payroll. It requires a single disk drive, small printer. Extended Basic and 16K. The program is also available for 32K Apples. $199.95. The **Construction Accounting System**, for Apple II Plus and Apple III, is a general ledger, payroll, job cost accounting and sub-contractor records system. $399.95. Charles Mann & Associates. 55722 Santa Fe Trail, Yucca Valley, CA 92284. (714) 365-9718.

CIRCLE 381 ON READER SERVICE CARD

Address Management System runs under CP/M and can print labels up to five across sorted on up to three fields. It works in conjunction with Magic Wand to produce customized letters. $150. Ivanco. 5131 Silver Arrow, Rancho Palos Verdes, CA 90274.

CIRCLE 382 ON READER SERVICE CARD

Advanced Data Systems has announced the expansion of its product line to include software for the 48K Apple. The following programs are available: **Business Plus**, a complete business system aimed at the small business owner ($299.95); **Mailmaster**, mailing list program that works with most popular printers ($69.95); **Intelligent Lister**, a program to format Applesoft and Integer Basic program listings ($34.99); **Master Copier**, a bulk diskette copier ($29.95); **Codex Catalog**, a disk catalog program ($34.95); and **Modem Utilities**, a collection of utilities for owners of the D.C. Hayes Micromodem II. $59.95. Advanced Data Systems. 7468 Maple Ave., St. Louis, MO 63143. (314) 781-9388.

CIRCLE 383 ON READER SERVICE CARD

UEMS is a commercially oriented bulletin board system designed for the transmission of information through a central host TRS-80 Model I with 48K of memory and two disk drives. The program allows for billing users for their time on the system and/or monitored access to particular pieces of mail. $150. Small Business Systems Group, Inc., 6 Carlisle Rd., Westford, MA 01886.

CIRCLE 384 ON READER SERVICE CARD

A **client write-up system** for CP/M systems is designed for the certified public accountant. The general ledger system includes a video journal entry program with automatic paging, on-line account verification, automatic journal balancing and control over nine separate journal books. Micronetics, Inc., 1926 Hollywood Blvd., Suite 328, Hollywood, FL 33020. (305) 925-2333.

CIRCLE 385 ON READER SERVICE CARD

Micro Associates announces three programs for the TRS-80 Model II. **Payroll with Invoicing** is a management tool for consulting firms, construction companies and contractors. **MatStat** is a program to generate and maintain material status reports for engineering and construction projects. And **ProSched** is a management program for estimating manpower requirements over the anticipated life of a project. All three programs are also available to run under CP/M in Microsoft Basic. Micro Associates, P.O. Box 6316, Metairie, LA 70009, (504) 831-3562.

CIRCLE 386 ON READER SERVICE CARD

Four software packages for business have been introduced by Personal Software Inc.: **VisiPlot**, a high-resolution plotting and graphics package ($179.95); **VisiDex**, a flexible personal information system ($199.95); **VisiTrend/VisiPlot**, a combination of VisiPlot graphics and a program for time-series manipulation, trend forecasting and descriptive statistics ($259.95); and **VisiTerm**, which allows a personal computer to communicate with a variety of other computers, ranging from mainframes to micros ($149.95). The programs are available for the disk-based Apple II and Apple II Plus with 48K of memory. Personal Software, Inc., 1330 Bordeaux Dr., Sunnyvale, CA 94086.

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Micro-Courier allows owners of Apple computers to transmit charts, graphs, correspondence, VisiCalc reports and entire programs to other Apple computers over the phone lines. $250. Also available

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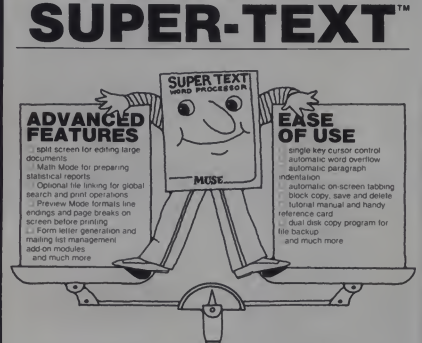

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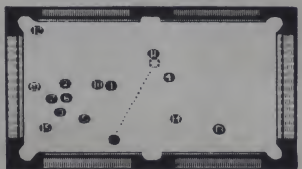

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is **Micro-Telegram** which allows Apple owners to access Western Union Service to send mailgrams and send and receive TWX, Telex and international cables. $250. Microcom, 89 State St., Boston, MA 02109. (617) 367-6362.

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The **Computerized Dictionary**, designed for the SouthWest 6809 computer, edits word processing text for spelling errors and changes them automatically. Davidson Software Systems, Box 21001, Lansing, MI 48909, (517) 332-5989.

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Proofreader works with any word processor to check for spelling errors using a 38,000-word dictionary. It is available for 32K TRS-80 Model I with disk ($54), 64K Model II with disk ($109), and 32K Model III with disk ($64). Soft-Tools, MHE Box 14, Tijeras, NM 87059.

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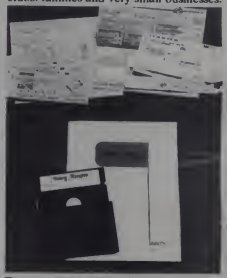

The system is available for CP/M systems with at least 48K of memory and 140K of disk storage. InnoSys Incorporated, 2150 Shattuck Ave., Suite 901, Berkeley, CA 94703, (415) 843-8122.

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Video Librarian is designed to maintain an accurate file of home video cassette programs and tapes. It can handle plot summaries, movie ratings, editing codes, running lengths, audience rating codes, hard copy print-outs, and personal notations. Available in Applesoft for the 48K Apple with DOS 3.2 or 3.3 $19.95. Softronix, Suite 1000, 4600 Park Rd., Charlotte, NC 28211, (708) 334-1958.

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MISCELLANEOUS

All entries in a rapid-retrieval **database** covering Apple literature through 1980 include article title, author name, periodical name, date of issue and page number. The product requires Applesoft in ROM and 48K of RAM. Annual updates will be available. $60. Connecticut Information Systems, 218 Huntington Rd., Bridgeport, CT 06608, (203) 579-0472.

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Using Ken's Compact Comma Calculator

Kenneth Delp

To comma, or not to comma—that is the question. That little mark of punctuation is a plague to many writers. We have all studied the rules, but we still get confused. Somehow editors and English teachers always seem to know where they go, yet we often still have the question, "Do I put a comma here or not?" With all the grammar books and usage manuals around, why one more explanation?

Maybe your experience was like mine. When I was in school, I was taught some rules about putting commas in between cities and states and dates and inside the quotation marks. There are a few other of these standard rules, but in sentences I was suposed to use a rule that went something like, "If you pause there, put a comma."

Well, that seemed reasonable to me, so I did. My papers came back with my commas circled in red, and the teacher had put in little red commas in other places. I mentioned that I only put commas where I paused. She replied, "You pause in the wrong places."

Somehow I learned to pause correctly.

Kenneth Delp, 362 Tamarack Lane, Prescott, AZ 86301.

and that served me well until I began teaching English and was faced with the problem of telling my students that they paused in the wrong places. I knew that there had to be more sense to the comma rules. When I began to search the available grammar books, I found two problems.

No book seemed to have all of the rules. There always seemed to be at least one or two missing. The other problem was that the rules were scattered throughout the books and clouded by mystical grammar terms like "introductory adverbial subordinate clause." I knew that my students would get lost in those terms. I also knew that they didn't have the time or wouldn't take the time to look on several different pages. So I set out to collect all the rules I could find, put them in one place, and arrange them in an easy-to-use format. The result is Ken's Compact Comma Calculator.

I wanted the calculator to be comprehensive. I wanted *all* the rules in one place. At the same time I wanted it to be only one page. One page, even if it was crowded, was more useful than several.

After collecting rules and examples, I found that they fit into only five main groups. These groups became the five basic rules of my calculator which are highlighted and boxed for quick reference. The acronym for the rules, SCIIS, can be remembered by the sentence: *S*ome *C*ommas *I*nvolve *I*nteresting *S*tudy. *S*eries. *C*oordinate. *I*ntroductory. *I*nterrupting. *S*tandard.

The calculator is set up with the grammar rules explained in the left column and a correspondingly numbered example in the right column. The examples are not complicated or long. Certain real live sentences in writing may have more words or use more than one comma. But my examples are limited to just one kind of comma use per sentence.

Many of my students have bypassed the grammar part. They simply make a reasonable assumption about which one of the five rules applies in a certain situation. Then they search the examples of that rule for a similar use. If you find the grammar too awkward or unfamiliar, this method works very well once you become familiar with the example sentences.

Rule 1: Series

Most people know this one, but they never know about the comma that goes

Reddy Chirra improves his vision with an Apple.

Reddy is an optical engineer who's used to working for big companies and using big mainframes.

But when he started his own consulting business, he soon learned how costly mainframe time can be. So he bought himself a 48K Apple II Personal Computer.

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and scientists, quickly learned the pleasures of cutting down on shared time and having his own tamper-proof data base.

His Apple can handle formulas with up to 80 variables and test parameters on 250 different optical glasses.

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And Apple's HI-RES graphics come in handy for design.

Reddy looked at other microcomputers, but chose Apple for its in-depth documentation, reliability and expandability.

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CIRCLE 106 ON READER SERVICE CARD

near the "and." Most authorities say that it is optional unless the reader would get lost without it. For this reason technical writing usually includes it to eliminate any possibility of confusion. For the same reason most magazines and newspapers don't bother when there is no doubt about the meaning. The basic structure of the series remains the same no matter how many items there are or how complicated those items become.

Rule 2: Coordinate

Coordinate simply means equal. When we join two short, equal sentences with a conjunction (they're listed in Rule 2A), we put a comma with the conjunction. The trick here is to remember that the small sentence (now properly called a clause) on each side of the conjunction must have a subject (an actor) and a verb (an action).

Part B of Rule 2 deals with equal adjectives. When these two describers are reversed and the meaning or sound hardly changes, then we include a comma. For example, we could write, "He was a happy, agreeable person." Or we could just as easily write, "He was an agreeable, happy person." Since the words are reversible, we include the comma to show that they're equal. How about, "He drove a little sports car"? "He drove a sports little car," just doesn't work.

Rule 3: Introductory

Rule 3 is used very frequently. The thinking here is simple. In a usual sentence the subject comes at the beginning, and the verb follows. However, if for some reason we write something in front of the usual sentence and we want the reader to suspend for a moment, we include a comma. We want the reader to be aware that there is introductory material. His signal is the comma. Several grammatical structures fill this bill, but generally this thinking will handle most situations. Look at the examples in the calculator.

Practice Paragraph

Here's a paragraph where I've included the comma rules above the commas. Try them and see how they fit the calculator.

In summary,[3A] the AB 1400 unit is a quick,[2B] reliable device,[2A] but we don't like its price. Although we found some problems with the documentation,[3B] they were easily overcome with only minor revisions. The accompanying interface,[4E] included at no extra cost,[4E] makes the system complete. The printer,[1A] the interface,[1A] and the unit itself are all available from Cactus Computer Connections,[5A] 1414 East Thirsty Circle,[5A] Death Valley,[5A] California.

Rule 4: Interrupting

The comma is the mildest interruption of the sentence. Dashes, parentheses, and ellipses (a series of three dots) interrupt more strikingly. These interrupting commas normally come in pairs. They indicate that the "regular" sentence is interrupted for a moment. The first comma of the pair indicates a break. The second indicates that the interruption is complete, and the main sentence is continuing.

Two notes are important. Some interruptions come at the end of the sentence. Obviously, in these cases there is no need for the second comma since the sentence is ended. You can see these situations in the second examples for A through F of Rule 4.

The other point to notice is with interrupting phrases and clauses, Rules 4E and 4F. This kind of interrupting information is sometimes necessary. The grammar description for this is called restrictive/non-restrictive. Rather than be that involved, I tell my students to think of the sentence without the information between commas. If the remaining sentence still makes good sense, the commas probably belong there telling the reader that the information is not absolutely necessary.

On the other hand, if there is some possibility of misunderstanding due to incomplete information, then the commas should be left out. The information then remains an integral part of the sentence. Remember, this question of importance is for interrupting phrases and clauses only.

Rule 5: Standard

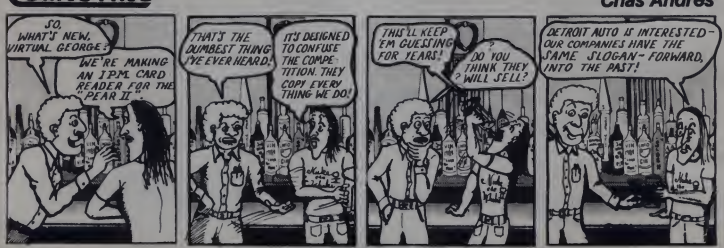
Nothing here should be a surprise. These rules are standard fare in all school classrooms. There aren't always clear reasons behind them other than tradition. Rule 5 on the calculator serves as a quick, clear reference for commas in standard places.

Summary

That's it. Ken's Compact Comma Calculator is designed to be a thorough but quick reference for comma usage. Since the comma is probably the most used punctuation mark next to the period, its proper use should be a consistent part of everyone's writing. It is a convention of our writing which provides clarity with minimal disruption of the flow of ideas. You can provide that clarity by referring to my Comma Calculator. □

POPULAR COMPUTING

Chas Andres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Ken's Compact Comma Calculator

DO NOT USE A COMMA UNLESS YOU HAVE A REASON

Use commas in the following situations:

1. between items in a **SERIES**.
_____, _____, and _____

A. words
B. phrases

C. clauses

1. **SERIES**
(The second comma is optional except when necessary for clarity.)
A. We bought *chips, cookies,* and *pop* for the picnic.
B. You can *remove the cover, adjust the drive belt,* and *replace the cover* with just one tool.
C. We cannot decide *what information we will store, how we will retrieve it,* or *how it will be used.*

2. in **COORDINATE** situations.
A. compound sentence with conjunction
(and, but, or, for, nor, so, yet)
B. adjectives
(only if they're reversible)

2. **COORDINATE**
A. You must set the dial, *and* the ready light must be visible.

B. It is an *efficient, inexpensive* unit.

3. after **INTRODUCTORY** elements in sentences.
_____, sentence
A. transition word or phrase
B. clause
(when, if, after, since, because, etc.)
C. noun of address
D. interjections (mild)
E. group of prepositional phrases
(in, on, over, under, through, etc.)
F. participial phrases and words

3. **INTRODUCTORY**

A. *First of all,* I want to explain the controls.
B. *After he retyped the memo,* Carl sent it to his boss.

C. *Thomas,* the door is still open.
D. *Well,* I didn't like the conference.
E. *In a rush of anger without a second thought,* he destroyed the experiment.
F. *Referring to the chart,* you will note the clear results of the research.

4. to set off **INTERRUPTING** elements. (These commas come in pairs except at the end of the sentence. See the second examples.)
A. parenthetical expressions

B. nouns of address

C. appositives
(more specific repeaters)
D. contrasting elements
(opposite repeaters)
E. phrases
(describing but not necessary)

F. clauses
(describing but not necessary)
(who, which, and that)

4. **INTERRUPTING**
part of sentence, _____, remainder of sentence.

A. The program, *admittedly,* is weak in some areas.
He will finish the project, *no doubt.*
B. In some cases, *Mr. Jones,* this rule helps.
Close the window, *Emma.*
C. The printer, *a tractor mechanism,* uses a simple control.
He bought a new car, *a compact station wagon.*
D. The software, *not the hardware,* is the problem in this case.
We remember our joys, *not our sorrows.*
E. The printed text, *displayed with or without the coding,* is usable for editing.
We enjoyed the new van, *painted with a bright mural.*
F. The line numbers, *which apply in most cases,* have little value in this situatipn.
We can't go to Tom's party, *which will be held in a rented gym.*

5. in **STANDARD** places.
A. between parts of address and after in a sentence

B. between parts of a date and after in a sentence

C. to set off the direct words of a speaker

D. in a business letter after the close
E. in a friendly letter after the opening and the close
F. to set off titles and after in a sentence
G. in an alphabetic listing of names

H. to change a statement into a question
I. in numbers

5. **STANDARD**
A. San Francisco, California
1000 Central Street, Dayton, Ohio
He was born in Phoenix, Arizona, after the war.
B. January 15, 1977 Monday, March 30, 1918
He won the race May 17, 1903, after many years of effort.
C. Tom said, "That is not true."
"It is possible," said Tom, "to complete the job in an hour."
D. Sincerely,
E. Dear John, Your friend,
F. William Phold, Jr., is the only son of William Phold, Ph.D.
G. Clasp, Tyler
Cloth, Terence
Shoes, James
H. Matilda is the boss here, *isn't she?*
I. 1,256 421,226,500

ings...TRS-80 strings...TRS

Stephen B. Gray

For the 32nd item in this string, let's examine Radio Shack's Pocket Computer sale price of $199, a pocket computer newsletter, some amusing personal-computer messages accompanying miniature pennies, 3M's regular and special filters for CRT screens, a program that lets you run Level-I programs on a Level-II machine, three programs (opera music, keyboard organ, games for children) from TSE Ramworks, and a short program to help pack your strings.

Pocket Computer "Sale"

A Radio Shack ad in the April 26, 1981, *New York Times* offered the TRS-80 Pocket Computer at $199, or $50 off the regular $249 price. Price reductions on a dozen other items, mainly hi-fi, were offered for a week, as "Grand Opening Specials," celebrating four new Radio Shack stores in the New York area.

A later Radio Shack ad in the *New York Times*, in May, offered the Pocket Computer at $199, for the month of May only, in celebration of Radio Shack's 60th anniversary.

In a Radio Shack ad in the May 21 *Times*: "First Time on Sale! The TRS-80 Pocket Computer," at $199, for a week only.

In May, a Radio Shack executive said, "After the end of May the price may never be this low again."

By the time you read this, the price may still be at $199. Radio Shack cut the price because Sharp Electronics Corp. (which manufactures the Pocket Computer and which gave Radio Shack an exclusive for a limited time) started selling it in May as the PC-1211, under the Sharp label.

A full-page Sharp ad in the May IEEE *Spectrum* magazine for "A Real Computer You Can Put in Your Pocket" doesn't mention the price, which was then $249. A Sharp executive told me, in May, that his company "has no plans to drop the price of the PC-1211; they're selling like hotcakes."

Also available in May was the Sharp CE-122, a combination printer and cassette interface at $150, looking very much like Radio Shack's cassette interface, but with a very small printer at its left end, using 1 1/2-inch paper. Sharp says they also have a CE-121 cassette interface, at $50, which is the same as the Radio Shack interface, at $49.

Sharp has three manuals for the PC-1211: an instruction manual, a Basic manual, and an applications manual with 125 (some say 137) programs. More on those after I see them.

The only difference between the two computers, other than the logos, seems to be that the Radio Shack Pocket Computer uses three batteries, while the Sharp PC-1211 uses four.

Pocket Computer Newsletter

A *Pocket Computer Newsletter* has been published since late 1980 by Nat Wadsworth, founder of Scelbi Publications (which offers books on assembly language, Basic, microcomputers, graphics etc.).

The newsletter is advertised as containing "news and product reviews, programming tips, operating timesavers, tutorials, short cuts, practical programs, technical details," etc.

The first five issues deal almost entirely with the Radio Shack TRS-80 Pocket Computer, the only pocket computer available during the period covered. Perhaps by the time you read this, others will be on the market.

Among the articles in the first five issues are programs for a memo pad, an alarm clock, tax calculations, estimating and billing, decimal-to-hex conversions, tic-tac-toe, and a numerical sort; reviews of the Radio Shack business financial program and Games Pack I; an item about the Panasonic/Quasar Hand Held Computer, a discussion of the nine interfacing pins on the cassette interface, several operating tips, and a programming form for the PC.

One of the operating tips is: "When editing numeric expressions or anything not enclosed by quotation marks, it is quicker to use the SPC key than the SHIFT DEL keys. When you hit the ENTER key the interpreter will remove any unnecessary spaces!"

For 20 issues of the newsletter, send $20 (In Canada, $24), to Pocket Computer Newsletter, Box 232, Seymour, CT 06483.

My Total Profits

A California entrepreneur has a clever gimmick: a tiny copper-clad replica of a Lincoln penny, 5/16 inch in diameter, mounted on cards bearing messages. They're sold "to the gamblers in Nevada and Atlantic City, and to the poor taxpayer" the letter says.

With the help of Paul Raymer, of Paul's Electric Computer, a Las Vegas software company, a dozen messages relating to personal computers were devised.

The messages range from "My total profits on programs I've written" to "My share of America's $100 million computer market," and also include "My change from a $20 bill after visiting a computer store," "My hourly rate as a computer programmer" and "Money I've saved doing my own programming." Several thousand

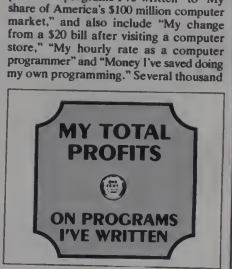

Figure 1.

have been sold "through selected computer-store dealers to date," the letter says.

Each mini-coin sells for about 50 cents (suggested list). A sample is 50 cents, but Mark Michael of BPC has kindly offered to provide 100 free assorted computer mini-coins to the first 100 readers of *Creative* who ask for one, and specify that they read this column. Send a self-addressed stamped envelope to Boardwalk Products Co., Box 74157, Los Angeles, CA 90004.

Other mini-penny messages are available, including "My bonus," "My gambling winnings," and "My life savings."The best

ACORN ARCADE!

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NEW!
TENPINS

By John Allen

John Allen works his machine language magic again! With the realistic action and sounds made famous by his bestselling "PINBALL" and "BASKETBALL" arcade games, TENPINS now brings all the thrills of championship bowling to your TRS-80* model I or III.

From one to four players participate, and the program automatically senses the skill of each player. Beginners can simply position the ball and "roll" it while more skilled players can vary the force, roll a curve, and cause it to spin as it heads for the pins. All this—plus 3-D graphics and sound effects—adds up to a realistic and thoroughly challenging bowling game.

Scoring, pinsetting and ball return are all automatic, and you can view the entire scoresheet at any time. TENPINS even has factors to simulate the imperfections found in bowling lanes, adding even more realism—and sometimes frustration—to the game. It's almost as hard to roll a perfect 300 score in TENPINS as it is in real bowling, but it sure is fun trying! Available for only $14.95 for 16K tape version, $20.95 for 32K disk.

PINBALL

By John Allen

Get your flipper fingers ready for action in this real-time, machine language game.

Lots of sound and flashing graphics make this fast action game so much like the real thing that you'll have to remind yourself not to shake your TRS-80*. Choose from five playing speeds to match your skill—but be prepared for a lot of practice if you ever hope to master the fastest speed.

Can you beat your friends' scores? Will you avoid the dreaded "Bermuda Square?" Get PINBALL today and find out. Available for model I and III, $14.95 on tape or $20.95 on disk.

BASKETBALL

By John Allen

Fast machine language action game, with sound, from the author of the acclaimed "PINBALL"!

Try to keep up with the action and outscore your opponent in five minutes of one-on-one basketball. Steal the ball, duck around your opponent and slant toward the basket for a lay up! The graphics are based on a 3-dimensional depiction of a basketball court, and ball dribbling sounds add to the realism. Compete against a friend or your computer.

It's all there but the cheers—for model I and III on tape for only $14.95, disk version for $20.95.

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Figure 2. CRT filter.

seller is "Tip for lousy service." Mini-nickels are mounted on Cash Award Certificates for "Greatest boss," "Jackpot winner," "Disco dancer," etc.

3M CRT Filters

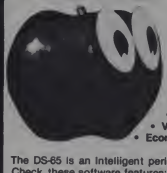
In the ads for CRT filters that occasionally grace the pages of this and similar magazines, the benefits are listed as improved image contrast, reduced eye fatigue, enhancement of screen legibility, decreased glare, giving the system a professional look, etc.

The most important seems to be decreasing the glare, one of the "ergonomic" factors often mentioned in articles about office-of-the-future terminals. In many installations, typewriters have been replaced with CRT terminals by simply removing one and installing the other, without checking out factors such as keyboard height, ease of document handling, and glare from nearby windows or other light sources.

3M's Data Recording Products Division has a variety of filters which they call films; we'll look at two of them. The Panel Film "selectively filters ambient room light, enhancing the CRT image by reducing glare," according to the press release.

The Light Control Film has, in addition, a horizontal "microlouver" construction that "limits the vertical angle from which the face of the terminal screen can be read, enhancing its confidentiality." A person standing behind a CRT terminal operator would have a very hard time trying to read the screen through this filter.

A Light Control Film, rotated 90 degrees, might be ideal for classroom use, to prevent



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—Picture Scanner: Provides a variety of different dithering algorithms for compressing the digitized image into the Hi-Res screen. Available on 13-sector disk. Price: $39.95

—Superscan: Enables you to enhance the DS-65's Hi-Res pictures with colors! Choose from 21 different colors and assign them to grey scale values, modify pictures, zoom, enhance contrast, etc. Print routines for the Anadex and Paper Tiger* are provided. Comes on a 13-sector disk. Written for The Micro Works by Magna Soft. Price: $79.95

—Portrait System Software: This program includes captions and a credit line, reverse printing for T-shirt application and the option to save portraits on disk. Specifically for use with a Mallbu 165 printer. Call or write for more information.

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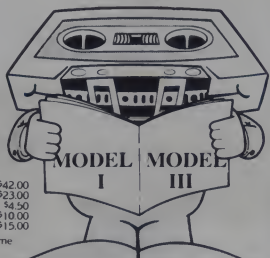
by Clyde Cload, star reporter

Goleta, Calif. — You can get 7 or 8 programs on cassette, each month, that **CLOAD** directly into your **TRS-80** Model I or III!

A subscriber, too engrossed in trying to save the world from invading aliens (March, 1981 issue) to give his name, stated, "I receive a 30 minute cassette by First Class Mail each month containing some of the best games and educational programs I have ever played. Some are even in machine language!" Another **CLOAD** subscriber, Claudine Cload, could now "fit the computer into her schedule" thanks to the utilities and occasional disk programs she received from **CLOAD.** She was writing about it to all of the people on her mailing list (November, 1979 issue).
Get the news firsthand. Get a subscription to **CLOAD** Magazine.



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students from peeking at adjacent screens during exams.

Glare reduction by both films is said to be equivalent to that of a 14-inch top hood on the terminal. The filters are applied, preferably on the inside of the terminal cabinet, with adhesive or double-sided tape. The filters aren't flat, but are formed to the standard radius of all CRT faces. Other standard diagonal-measure sizes are five, nine and 15 inches.

The 12-inch diagonal-measure filters, which fit the Model I, II and III TRS-80s, have suggested list prices of $20.55 each for one to 10, and $19.50 for 11 to 20 of the Panel Films; $38.90 for one to 10 and $36.95 for 11 to 20 of the Light Control Films.

These filters advertised in personal-computer magazines cost considerably less than $20.55 each, more like $13.95 or even $7.95. However, the couple I've seen at those prices were flat and rectangular with rounded corners, and are also curved convexly to fit as closely as possible to the screen, for maximum legibility.

If you use a computer CRT for any appreciable length of time, you may find that a filter helps cut eyestrain fatigue.

Level-I in Level-II

This program, previously available from Apparat, is a $14.95 16K Level-II program now marketed by TSE/Hardside, for running Level-I programs on a Level-II machine, or for making Level-I-compatible tapes on it.

Long ago I'd made up a tape of some Level-I graphics programs, and wanted to find out what they were. With the conversion program, I was able to load in the graphics programs, LIST and RUN them. (They can also be CSAVEd.) However, when I tried to LLIST one to a printer, I got WHAT? because there's no LLIST command in Level-I.

If you use Radio Shack's old "Program Conversion Level-I to Level-II" tape (which isn't listed in any catalog, but which I believe used to be shipped with Level-II machines), you can LLIST the programs to a printer. But you have to convert the Level-I programs one at a time, running the conversion program each time you want to convert. Whereas, with the TSE program, you can CLOAD a program, LIST and/or RUN it, and then CLOAD the next one, right away.

Incidently, when I couldn't find the file-names for these two conversion tapes anywhere, I ran the one-line program given in Short Program #20 at the end of this column, and got the names I needed to load them: LEVEL1 and CONV.

Programs can be edited under the Radio Shack conversion program, but not under the TSE program, with which you're still in Level-I, which has no editing facilities.

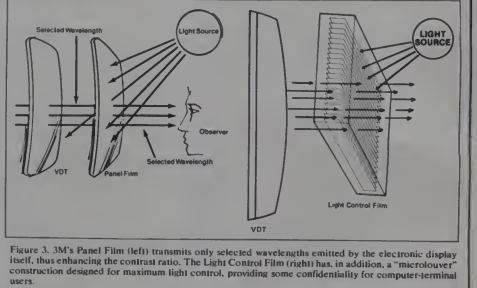

Figure 3. 3M's Panel Film (left) transmits only selected wavelengths emitted by the electronic display itself, thus enhancing the contrast ratio. The Light Control Film (right) has, in addition, a "microlouver" construction designed for maximum light control, providing some confidentiality for computer-terminal users.

Three From TSE Ramworks

TSE/Hardside, which markets a variety of software (and hardware) from outside sources (as well as publishing SoftSide magazine), also offers some of its own programs, under the Ramware name.

Let's look at three Ramware programs—Opera Theater, Keyboard-80, and Nine Games—from TSE/Hardside (6 South St., Milford, NH 03055).

Opera Theater

Listed in the catalog as "Opera Theater" and labelled on the 16K Level-II cassette as "TRS-80 Opera," this $9.95 Ramware item is more a demonstration of how much can be done with a monophonic music composer, than as musical treats for opera lovers.

Since the basic waveforms used for this music are quite simple, without the variety of overtones that give musical notes their character, the best way to dazzle the ears with music composers that can generate only one note at a time, is to play rapid passages of short notes.

This gives the illusion that several notes are heard at the same time, and/or that a virtuoso performer is playing complex passages with great skill, speed and accuracy.

The best example on this cassette is Rossini's *William Tell Overture*, performed with dazzling speed and with rapid arpeggios that seem to sound two and sometimes even three notes simultaneously.

The other four pieces are played at various tempos, but all include fast passages or arpeggios that sugest polyphonic music: "Sempre Libera" from Verdi's *La Traviata*, "Musetta's Waltz" from Puccini's *La Boheme*, "Queen of the Night" aria by Mozart, and "La Donna e' Mobile," from Verdi's *Rigoletto*.

Two of the opera selections are played too fast. However, the main point here is not the music, but a demonstration of programming skills with a monophonic music composer, and as such, this is a winner.

Try to LIST this, by the way, and you get a very strange mixture of meaningless characters, string packing and Basic lines, and message:

AS YOU SEE, THIS PROGRAM DOES NOT TAKE WELL TO LISTING.

Keyboard-80

For $9.95, the Keyboard-80 cassette "magically transforms" your 16K Level-II TRS-80 keyboard "into a three-octave organ," according to the small 12-page manual, which is mainly a "song sheet," with six tunes provided in keyboard notation.

To hear the music, plug the AUX cable from the computer into an audio-amplifier input.

Keys Z-M give you most of the first octave, keys A-J provide most of the second, and keys Q-I give the top octave. If you're a touch-typist, you'll have no trouble playing any of the six tunes provided in the manual. However, you'll have to figure out the rhythm yourself.

The keys provide only "white notes," without black-note sharps or flats, so there's a limit to what you can play with Keyboard-80. The "Happy Birthday" provided by the manual is in F:

A A S A F D
A A S A G F
A A Q H F D S
H H H F G F

so the first two H's in the last line, which should be B-flat, are actually B, so the tune sounds wrong at that point. If it had been written in C, no flats would have been required. The other tunes haven't

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48K BYTES RAM	YES	YES	YES
CASSETTE BAUD RATE	500/1000	500	500/1500
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PRINTER PORT	YES	YES	YES
REAL TIME CLOCK	YES	YES	YES
24 X 80 CHARACTERS	YES	NO	NO
VIDEO MONITOR	YES	YES	YES
UPPER AND LOWER CASE	YES	OPTIONAL	YES
REVERSE VIDEO	YES	NO	NO
KEYBOARD	63 KEY	53 KEY	53 KEY
NUMERIC KEY PAD	YES	NO	YES
B/W GRAPHICS, 128 X 48	YES	YES	YES
HI-RESOLUTION B/W GRAPHICS, 480 X 192	YES	NO	NO
HI-RESOLUTION COLOR GRAPHICS (NTSC), 128 X 192 IN 8 COLORS	YES	NO	NO
HI-RESOLUTION COLOR GRAPHICS (RGB), 384 X 192 IN 8 COLORS	OPTIONAL	NO	NO
WARRANTY	6 MONTHS	90 DAYS	90 DAYS
TOTAL SYSTEM PRICE	$1,914.00	$1,840.00	$2,187.00
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Hey kids, are the folks out of the room? Good, 'cause I've got a secret to tell you. You know that computer they fuss over? Well, kid, between you and me, this whole programming thing is a lot simpler than they realize.

What's that? Sure, you can learn. Just get a copy of **Computers For Kids.** It's a super book, and it tells you everything you need to know. Huh? You have an Apple? No problem. There's a version just for the Apple. One for the TRS-80 and one for the Atari too, with complete instructions for operating and programming.

The book will take you through everything programmers learn. Its easy to understand and the large type makes it easy to read. You'll find out how to put together a flowchart, and how to get your computer to do what you want it to do. There's a lot to learn, but **Computers For Kids** has 12 chapters full of information. You'll even learn how to write your own games and draw pictures that move.

Just so the folks and your teachers won't feel left out, there's a special section for them. It gives detailed lesson ideas and tells them how to fix a lot of the small problems that might pop up. Hey, this book is just right for you. But you don't have to take my word on that. Just listen to what these top educators have to say about it:

Donald T. Piele, Professor of Mathematics at the University of Wisconsin-Parkside says, **Computers For Kids** is the best material available for introducing students to their new computer. It is a perfect tool for teachers who are learning about computers and programming *with* their students. Highly recommended."

Robert Taylor, Director of the Program in Computing and Education at Teachers College, Columbia University states, "It's a good idea to have a book *for chidren*."

Not bad, huh? Okay, you can let the adults back in the room. Don't forget to tell them **Computers For Kids** by Sally Greenwood Larsen cost only $3.95. And tell them you might share it with them, if they're good. Specify edition on your order: TRS-80 (12H); Apple (12G); Atari (12J).

Your local computer shop should carry **Computers For Kids**. If they don't ask them to get it or order by mail. Send $3.95 payment plus $2.00 for one, $3.00 for two or more for shipping and handling to Creative Computing Press, P.O. Box 789-M, Morristown, NJ 07960.

creative computing press

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TRS-80, continued...

any problems with flats or sharps; "Marianne," "Battle Hymn of the Republic," "When the Saints Go Marching In," etc.

The organ is monophonic, playing only one note at a time. But with a little dexterity and fast arpeggio-playing with two or three fingers, you can create the illusion of almost-chords.

For that $9.95, though, you don't get much. For $14.95 you can get ORGAN (Sept. 1980, p. 188) from Micropute Software (Box 1943, Rock Mount, NC 27801). This 4K Level II program provides a two-manual, three-octave organ, with sharps and flats. And if you press two or three keys simultaneously, you get a warbling effect, as the notes alternate.

Also, you can change from loud to soft and back, from a clear tone to a nassal sound and back, and provide a range of tremolo and timbre values. As a bonus, the keyboard is displayed on the screen, and when a key is depressed, an asterisk appears on the corresponding displayed organ key.

Nine Games for Pre-School Children

George Blank, *Creative's* editorial director, who may be familiar to some of you as author of such complicated action games as Clipper, Santa Paravia & Fiumaccio, and Pork Barrel, turns his attention in this $9.95 16K Level-II collection to simpler games, for younger users.

All nine programs are run in double-width characters, for easier reading. The author, in the forward to the very brief 11-page manual, says he's taught four-year-olds how to use the programs in 15 minutes. They learned to press a number to take them from the menu to the desired program, to press CLEAR to stop a program or to change programs, to type RUN and press ENTER, and to press ENTER and try CLEAR again if the screen goes blank when they press CLEAR.

LETTERFUN uses the screen as a blackboard. The child enters letters or numbers until a control character such as ENTER is pressed. Then the word or phrase is repeated across or down the screen, or moved around the screen, or broken up and scattered around. The object of the game, the manual says, is to "increase letter recognition, pattern discrimination, and interest in words."

"The computer can be welcomed as one of our most promising forward steps. And if we fail to use the new opportunities which it offers us, let us at least be honest with ourselves. Let us then admit that it was man, and not the machine, that let men down."

John R. Coleman

ABC requires the child to type the alphabet in the correct order. Each correct letter makes an inch-high face smile; each wrong one makes the man shake his head.

LETTER WARS provides "practice in associating the large lower-case letters on the screen with the upper-case letters on the keyboard." This game is best played in a group. After ten letters are displayed, a space-battle ensues, with hits and counter-hits that indicate the child's score, which is then displayed as a percentage.

REPEAT simply fills a 32-character row with any character pressed, and is designed to "deliberately develop pattern recognition to prepare children for word recognition and art."

NAMES requires that an adult enter six names, and the computer then selects them at random and prints them in groups of 50. "This is also good practice for beginning readers to learn new words."

BLACKBOARD simply uses the screen as a 32-character-per-line blackboard, with the left-arrow acting as an eraser.

TROLL'S GOLD is a chase through a maze in which doors open and close at random. The child waits for the right door to open, presses an arrow key, and heads toward the pile of gold, door by door, and tries to get back to the starting place and up the stairs without getting caught and eaten by the troll. "The game teaches direction and eye-hand coordination."

MATH DRILL presents both numbers (for children who can read them) and graphics blocks (for children who haven't yet learned their numbers), and provides drills in addition and subtraction. The numbers to be added or subtracted don't go above nine, and subtraction doesn't result in a negative number.

CALCULATOR provides the four basic functions, with the difference that the display is in the form that children use in school, with numbers placed vertically above a line for addition, subtraction and multiplication, and within or to the left of the inverted L-sign for division.

The nine games combine fun with learning, are written to make playing them as easy as possible, and I wish my children had had the use of them before going to P.S. 9, because some subjects might have been made easier with these games.

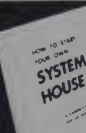
TSE/Hardside/Ramworks programs come with an Order Adjustment Form that asks if something is wrong, or missing, or broken, and if so, asks the purchaser to fill in the form, call for an authorization number, and return of the invoice along with the wrong or broken item. Sounds very efficient.

Short Programs #20 And #21

Here's a letter I should have used last year, from James A. Lisowski of the

HOW TO START YOUR OWN COMPUTER BUSINESS

Microcomputers today offer better opportunities to the small entrepreneur than any other industry. If you are looking for more than a 9 to 5 job for the rest of your life, the time to act is now. The HOW TO manuels from Essex Publishing will help you with facts and step by step guidance, as they have already helped thousands of EDP professionals, small businessmen and computer hobbyists.



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6th edition, March 1980

Written by the founder of a successful systems house, this fact-filled 220-page manual covers virtually all aspects of starting and operating a small systems company. It is abundant with useful, real-life samples: contracts, proposals, agreements and a complete business plan are included in full, and may be used immediately by the reader.

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HOW TO BECOME A SUCCESSFUL COMPUTER CONSULTANT
by Leslie Nelson, 2nd revised edition, Jan 1981

Independent consultants are becoming a vitally important factor in the microcomputer field, filling the gap between the computer vendors and commercial/industrial users. The rewards of the consultant can be high freedom, more satisfying work and doubled or tripled income. **HOW TO BECOME A SUCCESSFUL COMPUTER CONSULTANT** provides comprehensive background information and step-by-step directions for those interested to explore this lucrative field.

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FREE-LANCE SOFTWARE MARKETING 3rd edition, June 1980

Writing and selling computer programs as an independent is a business where • you can get started cheaply, with little capital investment • you can do it full time or part time • the potential profits are almost limitless. Since the demand for computer software of all kinds is growing at an explosive rate, the conditions for the small entrepreneur are outstanding.

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The book will guide you step by step through the process of marketing, advertising, negotiating a contract, installing software, training users and providing maintenance and support. It also contains sample software contracts that have been used in actual software transactions. Also included are tips on how to negotiate with a large corporation, ways of avoiding personal liability, techniques for obtaining free computer time and hints on how to run a free-lance software business while holding a full-time job.

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TRS-80, continued...

Milwaukee area (no address in the letter), with a correction and two short programs:

"In the May 1980 *Strings* you say [I was quoting from page 2/3 of the Level II manual] that the TRS-80 tape file-name 'may be any character other than double-quotes.' This is incorrect.

"Since the file-name is a string, you may have a file-name such as A$. This means you can also have a command that has the form CSAVE CHR$(34) which will give you a file with double-quote (") as a name.

"To prove it, make up a Basic program and save it as above. Then rewind the tape and type CLOAD"A". The TRS-80 will attempt to find file A. When it finds a file with the name other than A it will print the name it found, in the upper right video area, and in this case a double-quote will be printed.

"By selecting the number to be CHR$ed from page C/2 of the Radio Shack Level II Basic Reference Manual, you can have tape files with the left arrow, underscore, etc., as a file-name, including graphic characters!

(A brief note by Hank Obermeyer in the Oct. 1980 column, p. 183, said the use of CHR$ with string file-names gives a total of 256 file-names.)

"Here is another quickie: to find out the name of an unknown SYSTEM tape, type in and RUN this one-line program:

```
1 INPUT#-1,A$:PRINT A$
```

Set the tape volume correctly and start the tape by pressing PLAY. After a while something like

```
UTBUG
```

will be printed. Ignore the U, and the rest is the SYSTEM tape's file-name.

"Lastly, here is a program similar to Short Program #9 (May 1980, p. 150). It gives the ASCII value of a ROM/RAM address (the user selects the starting address), but allows the print speed to be dynamically controlled by pressing the number keys 1 through 7, using the entry as a delay factor.

"You can also run the display address-count backwards by pressing the up-arrow key at any time.

"Nasty print-control values are screened out and the program checks the port video-control line so that the screen will be CLEARed (and returned to 64 characters/line if a CHR$(23) induces the 32 character/line mode). It is numbered high so that you may merge it with a Basic program that you may wish to examine:

```
10000 DEFINT A-Z
10010 CLS:'BASIC STARTS AT 17129 DECIMAL
10020 PRINT 'UP-ARROW = BACKUP: 0 1-7 = DISPLAY DELAY RATE'
10030 INPUT 'START DISPLAY AT WHAT DECIMAL ADDRESS';N
10040 PRINT N, PEEK(N); CHR$(PEEK(N))
10045 IF INP(255)=63 CLS: PRINT N+23
10050 IF PEEK(14400)=8 THEN I=-1 ELSE I=1: 'BACKUP ON UP-ARROW
10060 IF PEEK(14352)<>0 FOR D=1 TO PEEK(14352)*50: NEXT: 'DELAY
10070 N=N+I: GOTO 10040: 'GET NEXT ADDRESS AND REPEAT
10080 'THIS IS AN IMPROVED BASIC/ROM/MEMORY ASCII PRINTER
10090 'JAMES LISOWSKI 1980
```

Figure 4.

The up-arrow feature doesn't seem to work; can you change the program so it will?

See also Short Program #14 (Dec. 1980, p. 196), which also displays the ROM contents "without messing up the screen with control characters," as the REM lines put it. □

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CIRCLE 133 ON READER SERVICE CARD

TRS-80 LEVEL II

Investment Analysis

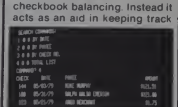
CS-3305 Cassette (32K) $24.95

This program was originally developed for personal use by an investment specialist. Creative Computing Software now makes this package available for you to analyze your investments and investment decisions. Programs in this package include regression analysis, stock market simulations, market/stock values, risk analysis, time related investments, and tax analysis.

Checking Account

CS-3304 Cassette (16K) $11.95
CS-3504 Disk (32K) $24.95
(Disk includes Text Processing, CS-3302)

This program does not replace the standard method of checkbook balancing. Instead it acts as an aid in keeping track of individual and monthly expenses. You enter the amounts and payees of individual checks, and save the information on cassette tape. The program then allows you to analyze your checks by payee or date of payment. Keep track of where your money is going and how effective your budget is.



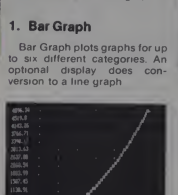
Graphic Package

CS-3301 Cassette (4K) $11.95

This package provides a variety of interesting and useful graphing routines. Graphing Package combines text and TRS-80 graphics to plot a variety of functions and other graphs.

1. Bar Graph

Bar Graph plots graphs for up to six different categories. An optional display does conversion to a line graph.

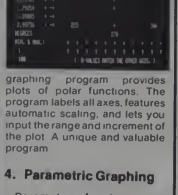


2. Cartesian Coordinate Graphing

This program plots a standard X, Y graph from a user entered function. A special feature of this program automatically scales of the Y-axis.

3. Polar Coordinate Graphing

Rarely found in computer graphing packages, this polar graphing program provides plots of polar functions. The program labels all axes, features automatic scaling, and lets you input the range and increment of the plot. A unique and valuable program.



4. Parametric Graphing

Parametric functions are functions in which both x and y are expressed in terms of an independent variable t. The resulting graph is X vs. Y. This program allows the user to input two parametric functions and produces a graph.

5. Linear and Parabolic Regression

These two programs are used for data analysis which can later be entered into the graphing routines. Regression routines analyze how well a series of points fit on a linear or quadratic function.

Tape Manager and Advanced Statistics

CS-3303 Cassette (16K) $24.95

CS-3505 Disk (32K) $24.95

This package may be the ultimate in statistical applications for the 16K TRS-80. Attractively packaged in a vinyl binder with a large instruction booklet, Advanced Statistics will provide you with the ability to perform statistical tests never before available on small computers. Its cassette based data file system allows you to store, retrieve, and transform data files for use in several different tests.

1. Tape Manager

Tape Manager, the heart of the statistical file management, allows you to create, edit, and transform data files. Unique to this program are features that allow the user to perform transformations on variables, extract and create subfiles, and selectively copy records. Up to twenty variables and an unlimited number of cases can be processed.

2. Descriptive Statistics

Descriptive Statistics computes the mean, standard deviation, standard error of estimate, variance, skewness, kurtosis, range, median, and quartiles for a variable and constructs a histogram for each value. A test scoring option for conversion of raw scores into percentiles is included.

3. Two Variable Statistics

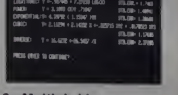
This program calculates descriptive statistics for each variable. It performs a t-test for the difference of means, computing the product-moment correlation coefficient and its associated significance level. In addition, it performs linear regression and computes standard error of estimate for Y.

4. Crosstabulation

This program constructs contingency tables for displaying frequencies, column percentages and table-wide percentages for each cell. It computes the Chi-square, the level of significance and gamma statistics. Tables as large as 10x10 may be evaluated.

5. Regression-Trend Analysis

This program computes least-squares regression coefficients from time-series or paired data for best-fit equations (linear, parabolic, hyperbolic, logarithmic, power, exponential and cubic types). Calculates standard error of estimate for each equation and more.



6. Multiple Linear Regression

Performs multiple linear regression using up to ten independent variables. The program computes both unstandardized and normalized coefficients, covariance, multiple correlation coefficient, and the standard error of estimate.

7. Correlation Analysis

Computes product-moment correlation matrices, multiple correlation coefficients and partial correlation coefficients with their associated significance levels.

8. Analysis of Variance

This program performs one-way and two-way analysis of variance for a maximum of ten groups in each control variable. Statistics include the mean and standard deviation for each group, sum of the squares, degrees of freedom, mean square, F-ratios, and significance level.

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Economic and Ecology Simulations

The Ecology Simulations series are a unique educational tool. They are based on "simulation models" developed by the Huntington Two Computer Project at the State University of New York at Stony Brook under the direction of Dr. Ludwig Braun. The programs and accompanying documentation are written for self-teaching or classroom use and include background material, sample exercises and study guides. Graphic displays were specially developed by Jo Ann Comito at SUNY and Ann Corrigan at Creative Computing. The Ecology Simulations packages are a remarkable educational application of micro-computers.

Ecology Simulations-1

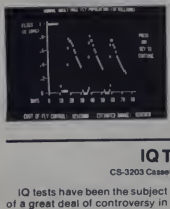
CS-3201 Cassette (16K) $24.95
CS-3501 Disk (32K) $24.95

1. Pop

The POP series of models examines three different methods of population projection, including exponential, S-shaped or logistical, and logistical with low density effects. At the same time the programs introduce the concept of successive refinement of a model, since each POP model adds more details than the previous one.

2. Sterl

STERL allows you to investigate the effectiveness of two different methods of pest control—the use of pesticides and the release of sterile males into the fly population. The concept of a more environmentally sound approach versus traditional chemical methods is introduced. In addition, STERL demonstrates the effectiveness of an integrated approach over either alternative by itself.



3. Tag

TAG simulates the tagging and recovery method that is used by scientists to estimate animal populations. You attempt to estimate the bass population in a warm-water, bass-bluegill farm pond. Tagged fish are released in the pond and samples are recovered at timed intervals. By presenting a detailed simulation of real sampling by "tagging and recovery," TAG helps you to understand this process.

4. Buffalo

BUFFALO simulates the yearly cycle of buffalo population growth and decline, and allows you to investigate the effects of different herd management policies. Simulations such as BUFFALO allow you to explore "What if" questions and experiment with approaches that might be disastrous in real life.

IQ Test

CS-3203 Cassette (16K) $14.95

IQ tests have been the subject of a great deal of controversy in the past few years. Yet, few of us know our IQ score. Now you can find out with our IQ test.

Taking advantage of the TRS-80's graphic capabilities, this test consists of 60 multiple choice questions. A special machine language routine does the scoring of the test and makes cheating almost impossible.

Ecology Simulations-2

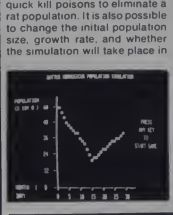
CS-3202 Cassette (16K) $24.95
CS-3502 Disk (32K) $24.95

1. Pollute

POLLUTE focuses on one part of the water pollution problem; the accumulation of certain waste materials in waterways and their effect on dissolved oxygen levels in the water. You can use the computer to investigate the effects of different variables such as the body of water, temperature, and the rate of dumping waste material. Various types of primary and secondary waste treatment, as well as the impact of scientific and economic decisions can be examined.

2. Rats

In RATS, you play the role of a Health Department official devising an effective, practical plant to control rats. The plan may combine the use of sanitation and slow kill and quick kill poisons to eliminate a rat population. It is also possible to change the initial population size, growth rate, and whether the simulation will take place in an apartment building or an entire city



3. Malaria

With MALARIA, you are a Health Official trying to control a malaria epidemic while taking into account financial considerations in setting up a program. The budgeted use of field hospitals, drugs for the ill, three types of pesticides, and preventative medication, must be properly combined for an effective control program.

4. Diet

DIET is designed to explore the effect of four basic substances, protein, lipids, calories and carbohydrates, on your diet. You enter a list of the types and amounts of food eaten in a typical day, as well as your age, weight, sex, health and a physical activity factor. DIET is particularly valuable in indicating how a diet can be changed to raise or lower body weights and provide proper nutrition.

Social and Economic Simulations

CS-3204 Cassette (16K) $24.95
CS-3507 Disk (32K) $24.95

1. Limits

LIMITS is a micro-computer version of the well known "Limits to Growth" project done at MIT. It contains a model of the world that is built of five subsystems (population, pollution, food supply, industrial output, and resource usage) linked together by six variables: birth rate, death rate, pollution generation, resource usage rate, industrial output growth rate, and food production rate.

2. Market

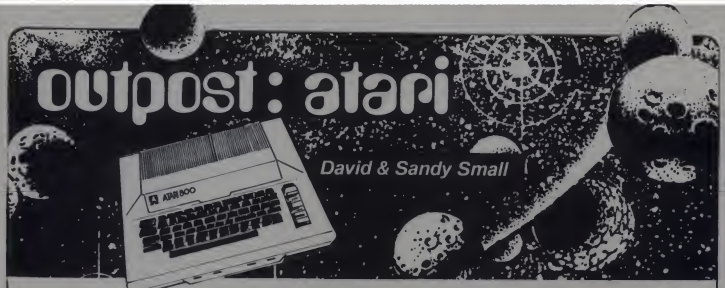
Market allows two or more people to play the roles of companies who are competing for the market for a particular product: in this case, bicycles.

Each player makes marketing decisions quarterly including the production level, the advertising budget, and the unit price of the product for his/her company.

3. USPop

USPOP allows the user to study many aspects of the United States' human demography (population change) including population growth, age and sex distribution. USPOP makes population projections and investigates the consequences of many different demographic changes.

(Available in November).



Over the last two months we've discussed the Atari display list (DL) and its graphics-characters capabilities in separate articles in *Creative*. In this column we'll look at some of the higher-powered features of the DL and provide a complete table of display list opcodes for future reference.

First, a note from a friend at Atari. In the last article, we found the display list via: START = PEEK(741) + 256*PEEK (742) + 1. This can be simplified by using: START=PEEK(560)+256*PEEK(561). The 560-561 pointers to the display list point directly to the DL, not to the byte before it, as do the 741-742 pointers, and are more reliable under strange operating conditions, I'm told. I'll use the 560-561 pointers from now on.

The display list, you'll recall, is a program written for a special processor called Antic. Antic handles much of the display generation for the Atari and leaves the main 6502 processor available for other work. Last month we discussed the character and graphics opcodes for the Atari; this month I'll present a complete list of all the opcodes, then devote the rest of the article to notes and explanation. I'll try to keep the list short and concise, for reference purposes, and leave the explanations and examples for later. At first it will probably seem confusing, but read on.

Display List Opcodes

There are three main groups of DL opcodes. There are also some modifiers which may be applied to the "base" opcodes, much as a sharp or flat may be applied to a base musical note. However, just as certain notes may not be modified with a sharp/flat, certain DL opcodes may not be modified in certain ways.

Blanking opcodes. When Antic encounters one of these, he generates a certain number of blank display lines (background). He doesn't look to display memory or do anything else; he just takes a break and generates blank scan lines. From one to eight blank lines can be generated by these opcodes. The blank line, like any display block, extends all the way across the screen horizontally.

Modifiers: Only a display list interrupt may be added to these opcodes.

Character/Graphics opcodes. When Antic encounters one of these, he fetches bytes from display memory, determines the graphics mode, and puts something on screen. A complete list and discussion of these is available in "Atari Graphics Unveiled" in the June and July issues of *Creative*.

Modifiers: Horizontal scroll, vertical scroll, load memory scan and a display list interrupt may be added here.

Two special codes. JMP is a JUMP for

David and Sandy Small, 11314 Yucca Dr., Austin, TX 78750.

Blank Lines

Number of blank scan lines	Hex opcode	Decimal opcode
1	00	00
2	10	16
3	20	32
4	30	48
5	40	64
6	50	80
7	60	96
8	70	112

Character / Graphics Modes

Basic Graphics Mode (if any)	Vertical Size	Horizontal Size	Colors	Graphics/ Character	Hex	Decimal
0	8	8	(2)	C	02	2
—	10	8	(2)	C	03	3
—	8	8	4	C	04	4
—	16	8	4	C	05	5
1	8	16	5	C	06	6
2	16	16	5	C	07	7
3	8	8	4	G	08	8
4	4	4	2	G	09	9
5	4	4	4	G	0A	10
6	2	2	2	G	0B	11
—	1	2	2	G	0C	12
7	2	2	4	G	0D	13
—	1	2	4	G	0E	14
8	1	1	2	G	0F	15

Special Instructions

JMP 01 hex (01 D)
JVB 41 hex (65 D)

Table 1. Display List Opcodes.

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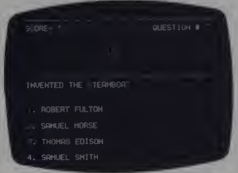

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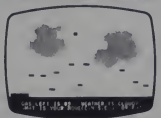

Fishing Trip. Try to catch flounder and salmon while avoiding logs, sharks, bad weather and running out of fuel.

Treasure Island II. Same game except you have to use a metal detector to find the treasure.

Original Adventure

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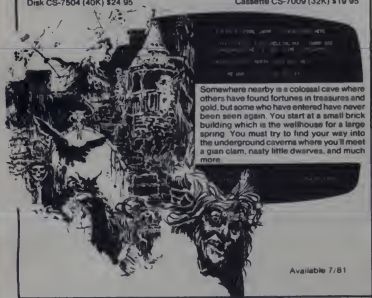

Somewhere nearby is a colossal cave where others have found fortunes in treasures and gold, but some who have entered have never been seen again. You start at a small brick building which is the wellhouse for a large spring. You must try to find your way into the underground caverns where you'll meet a gian clam, nasty little dwarves, and much more.

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Atari, continued...

Antic, it tells Antic to continue looking for instructions elsewhere. It is an equivalent to a GOTO in the display list. It is followed by a 16-bit address of where to continue.

JVB is a jump to the start of the display list, and wait for a new screen refresh to begin (automatically). It is followed by a 16-bit address, which by the way doesn't have to be the start of the original display list; it can also be a completely new list. The important point is that JVB waits until the screen is refreshing again before allowing Antic to continue.

Modifiers: Only a display list interrupt may be added here.

Modifiers

To add a modifier to a given opcode, just add the number shown for that modifier to the base opcode, then use the number for the opcode.

Horizontal Scrolling. This capability added to an instruction means that section of the display may be smoothly scrolled in a horizontal direction. Add 10 hex (or 16 decimal).

Vertical Scrolling. This capability allows smooth vertical scrolling. Add 20 hex or 32 decimal).

Load Memory Scan. (A three-byte instruction is implied if you use this opcode.) This tells Antic where to find display memory, and resets Antic's pointer to that location, no matter where he currently is. Add 40 hex (64 D) to use this.

Display List Interrupt. The execution of this instruction causes Antic to force the 6502 processor to interrupt (to the location specified in locations 200 and 201 H (512,513D). Requires writing to a location to allow interrupts.

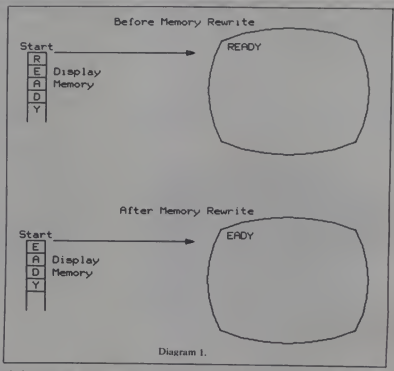

Diagram 1.

Notes and Discussion

Concerning Modifiers:

1. Horizontal and vertical scrolling are neat additions to graphics capabilities. They are there to help make your job easier and provide some effects that you would otherwise have to work hard to generate.

Scrolling is making the display appear to "roll by—an object on the display comes into view, is run across the screen, and disappears on the other side. (The Atari coin-op game where you fly over enemy terrain, bombing targets that roll underneath you, is an example of scrolling. This game could be implemented on the 400/800, if you're looking for a saleable project, by the way.) Normally while editing you'll see the Atari scroll data up off the top of the screen.

In order to have a display "scroll," we must first output it to the TV in unmoved format, then move it, then output it again. This will cause the display to shift once. Repeatedly doing this causes a scrolling effect. All our displays, generated by Antic, are stored in memory and are put on the TV 60 times a second, so what we have to do is change display memory in such a way that it will cause a scroll.

If the display memory is changed so that all information in it is copied 40 bytes up, in graphics 0, then on the next refresh the former top line will be replaced by the information in the line below it (lines are 40 bytes long, remember). You've seen this effect when the Atari scrolls something up offscreen, as during a long set of PRINT's. And, if we were to move the data in the display memory up just one byte, the screen would appear to move to the left, for the contents of the second byte would now be displayed in the TV position of the first byte, and so on down the screen. (See Diagram 1.)

This is a good way to do scrolling *if* you are working in assembly language. The amount of data that must be moved, however, (960 bytes in graphics 0) is so large that it becomes impossible for Basic

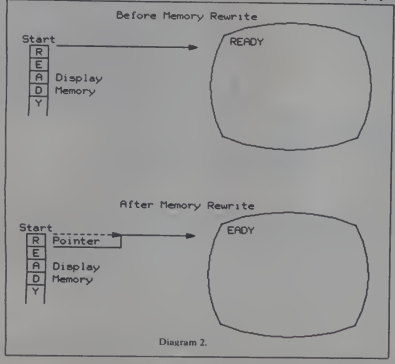

Diagram 2.

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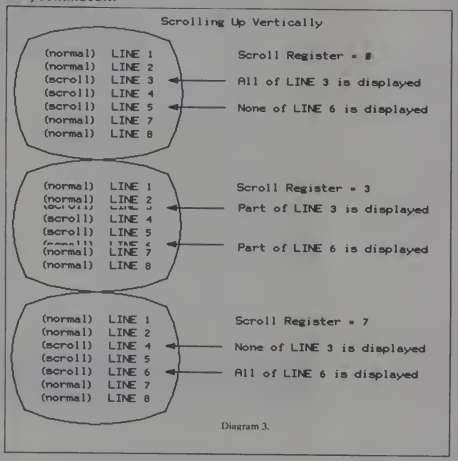

Diagram 3.

to do the job quickly enough. There is a way to do scrolling from Basic without moving a large block of memory. Instead of having Antic look at the same place in memory for display memory and moving things around in memory, let's change where Antic looks and leave the memory alone. (Diagram 2.)

For example, if we were to tell Antic that screen memory started one byte down from where it really did, Antic would miss the first byte of memory, and the entire screen would seem to scroll to the left. Antic wouldn't know the difference (or care), but to us, the screen will seem to have scrolled horizontally. If we were to tell Antic the screen memory starts 40 bytes down from where screen memory actually starts, he'll miss the first line of data (assuming graphics 0), and the screen will scroll up. You can obtain some neat demonstration displays this way. Try Program 1 to scroll the screen horizontally, Program 2 to scroll it vertically, and Program 3 to do it both ways! These programs all just modify the pointer Antic uses to find display memory, and are a good deal of fun to leave running in a computer store.

However, all this gives us is coarse vertical/horizontal scrolling. When we rewrite display memory or such, we shift things eight dots or eight scan lines (in graphics 0). This gives us a very jerky display. So, Atari provided us with the capability to smooth out the scroll; you can shift the display vertically or horizontally the number of "fine" dots you need to make it smooth, then rewrite display memory or change Antic's pointer to continue. You cannot scroll more than the distance between coarse scrolls; you can think of it as fine tuning only between channels if you like. It is limited to 0-7 (or 0-16 depending on mode) dots scrolled, which neatly fits our graphics 0 scroll.

On the Atari, scrolling is only a positive value. In other words, you cannot scroll something "down" using the scrolling register; you must start with it fully scrolled up and scroll it "less upwards" to achieve a downward effect. How much you wish a display scrolled up is written into a mapped memory location.

Thus, in order to make a smoothly scrolling vertical display, we need to select our "coarse" vertical position with the display memory and such, then select how many "fine" scan lines to go up from that position. Presumably we would increment the number of lines to go up, to move the whole display up. When we reach seven increments, our capability to fine scroll is finished, and we have to rewrite display memory (and set our vertical scroll to 0) to get that eighth scan line up. Then we would start over with incrementing our vertical scroll location. A downwards scroll is nearly the same thing; just have it start at +7 scroll, then work down to 0, shift memory, and so on.

The display list entry for a given display block must be modified to allow scrolling. If you write something to the scroll register, but don't change the display list, nothing will happen.

Here are some details on how fine scrolling is implemented:

Antic normally displays a fixed number of scan lines per display mode. Well, when we scroll vertically, Antic doesn't do this anymore. When Antic encounters the beginning of a "scrolled zone—"a group of display list opcodes with vertical scroll modifiers—he treats the beginning and end of the scrolled zone differently than he normally would. Display blocks in the middle of a scrolled zone are handled normally. When he first finds a scroll-marked display block, he doesn't display the normal number of scan lines for that display block. He only displays the bottom slices of the display block, the exact number determined by what is in the scroll register. Because the top line of the scrolled zone then becomes shorter than it normally is, the lines below it seem to move up. (Diagram 3.)

The lines in the middle are displayed normally, then when Antic reaches the end of the scrolled zone, he only displays the top few lines of the last scrolled display block. Again, how many he displays is determined by the scroll register. This is necessary to make the total number of scan lines in the scrolled zone remain constant. Why? If the total changes, the display below the scrolled area will move, depending on the scrolled area. By having the top and bottom display blocks short, but the total of them adding up to one display block size always, we get a fixed size scroll zone. Also note that we will have "lost" one display block in the scrolled area; remember, only pieces of two display blocks, whose total is one display block, are shown. One stays missing.

This is a strange but effective way of doing things. If you run Program 4, you will see vertical scrolling in action. This program writes two separate vertical scrolled zones into the display list, then scrolls them. Note that the display shrinks two scan lines when you run the program; this is the missing top of the top line and bottom of the bottom line (adding up to one display block height) in two places; hence there are two less displayed lines. Also note how the scrolling letters seem to disappear behind the fixed letters. They aren't really disappearing, they are just not being displayed completely.

This capability requires some experimentation which may make clearer what

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Binary Beatles

by David Ahl

Computer music. Who needs it? It's mostly boring beep, beep, beeps or wildly modern stuff. It's certainly nothing you'd want to listen to more than once. That's what I thought about computer music and most of my friends agreed.

In 1978 I entered Yankee Doodle Dandy into my Software Technology system just to be different. Dick Moberg heard of it and asked me to perform in the Philadelphia Computer Music Festival. I agreed expecting to be the only one with something out of the ordinary. I was wrong.

Computer Accompanist

Nine individuals and groups performed in the festival. There were the usual Bach pieces but even they were different. Gooitzen van der Wal performed the last movement of the 2nd Bach Suite in a unique way. He played the flute solo while using the computer as accompaniment.

Then Dorothy Siegel did the same thing, playing the clarinet solo part of Wanhal's Sonata in b flat. The audience went wild.

Hal Chamberlin played Bach's Tocatta and Fugue in d minor. But also with a difference. He used a large computer before hand to "compute" the waveform of every instrument playing every note. It took one hour of computation time for each two minutes of playback time. The result could hardly be distinguished from the organ in the Hapsburg Cathedral.

Don Schertz had a home brewed synthesizer truly mounted on a breadboard that allowed him to control 25 parameters of each note. It produced spectacular sounds in his arrangement of Red Wing.

Singing Computer

In 1962, D.H. Van Lenten at Bell Laboratories produced the first talking computer. Bell engineers taught it to recite the soliloquy from Hamlet. Then they went one step further and taught it to sing Daisy both alone and accompanied by another computer. This was also performed at the festival.

Yes, the Beatles were represented. Andrew Molda played Hey Jude on his COSMAC VIP system with a program called PIN-8 (Play it Now).

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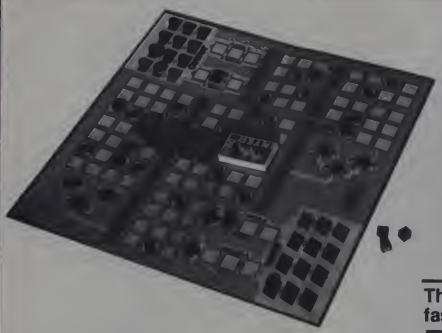


High Roller

Three binary dice add up to fast fun and easy winnings

Binary dice? That sounds strange. What's the point?

Each binary die has six sides but instead of one to six spots, three sides have the numeral one and three have a zero. When rolled, the three dice, red, blue and green, produce a 3-bit binary number.

The binary number can be easily converted to a decimal numbr. A binary 101 equals a decimal 5. After using these dice a few times, these conversions are quickly done even by 7 year olds.

Designed for Understanding

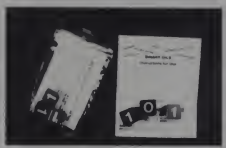
Binary dice are just one of many unique elements of the *Computer Rage* board game. The whole game is designed to help players easily understand the complexities of a large multiprocessing computer system while having great fun playing.

Imagine you're using a large computer along with many other users. It's Thursday and payroll checks have to be run. They have priority over your job. When this happens in the game you lose a turn. But then a vice president wants the results from the program you're working on—take another turn. Oh, oh, in your hurry, you make a program mistake. Too bad—return to the last checkpoint.

Meanwhile one of your opponents, a fellow user of the computer, has heard from the president that one of his three programs has top priority; it advances to the output queue. But wait, on your next move you land on an "interrupt" and find that a brownout has just occurred, the computer has crashed, and all the programs of all players must return to the last checkpoint.

The binary dice return to your opponent. He rolls 011, a four, and lands on a decision point. Rolling one die he gets a 1 which means he takes an 8-step flow intead of a 16-step one.

One it goes until one of the two to four players gets all of his programs to the output printer and wins.



Sets of three binary dice used in Computer Rage are available separately.

Sturdy Components

The game comes with a colorful, big 19" x 19" playing board, 38 interrupt cards, 12 miniature disk pack playing pieces (3 for each player) and 3 binary dice. A supplement to the rules describes the way in which *Computer Rage* parallels a multiprocessing system.

Computer Rage is designed for players from 7 to 14 years old but obviously can be played by adults as well. It is for two to four players. Many schools use the game along with a book such as *Be A Computer Literate* in computer literacy units for Grades 3 to 8. It's also an excellent game to have available in open or alternative classrooms.

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CIRCLE 350 ON READER SERVICE CARD

Atari, continued...

I've been saying; Atari uses some tricky hardware to make their machines work as they do. Horizontal scrolling, by the way, should give you some entertainment as it involves modifying the amount of data per line in the display memory.

The vertical scroll register is at D405 hex (57239 D), and the horizontal scroll register is at D404 hex (57238 D).

2. Load Memory Scan (LMS)

This instruction is very useful and quite necessary to know about if you're doing much graphics work. It is a helpful tool for advanced graphics but using it is necessary in other applications due to the way the Atari hardware is designed.

When Antic first learns where display memory is, it takes that 16-bit value and puts it into a register inside itself. When it wants data from memory, such as a line of characters, Antic looks to this register to find out where it currently is in display memory. It then fetches the byte at that location, and increments the register so it points to the next byte. Trouble is the internal register is only 12 bits. (The other four bits are latches, if you're interested.) This means that as Antic goes along, if it hits a 4K boundary in memory (goes past a 1000 hex address point), it will run out of "fingers to count on" and start all over again!

This has caused extreme frustration at Atari, I'm told, and is one of the most difficult-to-debug and commonplace problems encountered in Atari programs. So remember, don't let your display memory cross a 4K boundary without resetting that pointer via a load memory scan. Place the 16-bit value of where to continue in display memory in the two following bytes. By the way, you've seen this instruction before; it's the 66 near the beginning of the display list. The 66 is a two (or graphics 0, one line) instruction, with a 64 modifier added to it. (If you counted the display list example in the previous article, there's only 23 GR.0 instructions, and one 66 instruction to make up 24.) The 4K boundary means 4K in absolute memory address, not relative to the DL.

This instruction also accounts for some of the graphics 8 display list instructions. Graphics 8 uses 7680 bytes of display memory, well past the 4096 byte Antic limit, and it thus needs this instruction to reset the pointer. If you dump the GR. 8 display list, you'll see what I mean.

I should also mention before it drives someone to insanity that the display list itself cannot cross a 1K boundary because of the same sort of thing. Antic's pointer to where it is in display list is 16 bits long, but the top six bits are latches only; they cannot count. You must use the JMP instruction to pass a 1K boundary in the display list (1048 decimal). If you start getting screwy display list results, you may have passed a 1K boundary with the DL or a 4K boundary with the DM without using JMP/LMS to reset the pointers.

3. Display list interrupts.

Setting this bit (those of you with binary counting experience may now realize that the modifiers are just top bits set in the opcode) causes the 6502 processor to be interrupted, and sent to the location specified in 200 and 201 hex. This is a really handy capability; you can have the 6502 busily doing something else, and when the display reaches a certain point, you can have the 6502 interrupt what it's doing for a special update. One example that comes to mind is changing a color register halfway down the screen to get more than four colors displayed at once. Using this capability requires some assembly language work, and I will provide an example of it in a later article. In the meantime, those of you who know assembly can POKE into 200 and 201, and use an RTI to get back once done processing.

After the display list instruction is executed, you'll interrupt to your service routine. By the way, you'll also need to write a C0 hex (192D) into location D40E (or 54286D) to enable this type of interrupt. Because of the usefulness of DLI's, I will include two general purpose assembly routines in a later article devoted to assembly aids for Basic (primarily in player-missile and DLI related items); one shifts all color registers to user-determined values wherever the user places an interrupt, the other is a kind of color display list, where every display block has five colors for the color registers and displays its data in those specified colors.

Conclusion

Well, there you have it, a complete list of DL opcodes. You can do a tremendous amount with this powerful tool. Look at what's been done on the Apple, a machine without the power of the display list, for example. Apple users have the equivalent of the Atari without the display list or other graphics tools and only a few graphics modes, and someone managed to implement Galaxian on it!

Coming up next month, now that we've covered the display list quite thoroughly, is Player-Missile graphics. This is the second graphics generation system on the Atari and will give you more power than ever. The display list alone is extremely powerful, especially with capabilities to synchronize the 6502 and interrupt on a given display block; Player-Missile should give you the final powerful tool to do about any animations you wish on your custom display (list) background.

Good luck and happy hunting with your Atari! (Our thanks to ComputerLand in Austin, Texas for allowing me to use their equipment to check these programs.) □

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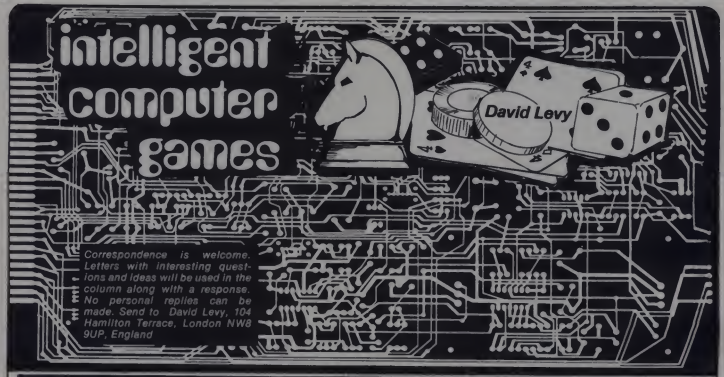
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Correspondence is welcome. Letters with interesting questions and ideas will be used in the column along with a response. No personal replies can be made. Send to David Levy, 104 Hamilton Terrace, London NW8 9UP, England

GO-MOKU

This month we shall look at a game with an enormous number of possible moves at every juncture. The game is known as Go-Moku in most Western countries, though in Japan it is called Jenju. Go-Muku is a two-person game played on a Go board using Go stones; it is the size of the Go board (19 x 19) that gives rise to the enormous branching factor of the game tree.

Black always starts and makes a move by placing a black stone on any of the intersections. Thereafter, the players move alternately and the player who first completes a horizontal, vertical or diagonal line of five of his own stones is the winner.

Since five men in a row is enough to win, if you get four men in a row with the two adjacent intersections (at each end of this row) vacant, then on the next move you can complete a row of five (unless your opponent can do so immediately). So an unblocked row of four men is a winning formation. It is now easy to understand that if you have a completely open row of three you are threatening to force a win by making it into an open row of four on the next move and then a row of five on the following turn. The threat to convert a completely open row of three into an open row of four can normally be blocked, simply by closing the row of three at one end and then, when the opponent places a stone at the other end of the row to make a row of four, it is possible to block the only open end of the row of four to prevent it becoming a row of five.

Although it *is* possible to counter the threat of making one completely open row of three into a open row of four, it is obviously not possible to counter two such threats if they exist simultaneously. Thus, the most fundamental winning tactic in Go-Moku is to try to force a position in which you have, simultaneously, two completely open rows of three stones. The simple examples of Figure 1 will help to illustrate these principles.

The following rather obvious statements should be sufficient to teach the absolute beginner enough so that he can understand the principles of the game:

A) The four black stones at N7, O7, P7 and Q7 in Figure 1 form an open row of four. Unless, on his next move, White can complete a row of five stones elsewhere on the board and thereby win the game, White has no way to avoid defeat. If he plays on M7 then Black will play on R7 and win, and vice versa.

B) The white stones at C6, D6 and E6 form a completely open row of three. Unless Black takes remedial action against this row, or unless Black can himself force a win on some other part of the board, this row of three threatens to win by becoming an open row of four. For example, if it is now Black's turn and he plays a stone on some useless point, White may place a stone at B6 for F6, in either case creating an open row of four which next move will become a winning row of five.

C) If we now add to the board two more white stones, on F5 and G4, we can see that unless Black has a win on some other part of the board, White will win by making one or other of these rows of three into an open row of four on his next move. Black may stop the horizontal row by placing a stone at B6 or F6, or he may stop the diagonal row by placing a stone at H3 or D7, but he cannot do both simultaneously; and whichever row he does not stop immediately will grow on the next move into an open row of four and then into a winning row of five.

Because this double threat, created by simultaneous rows of three, is absolutely decisive, the game loses much of its interest if no restriction is placed on the players. Try for yourself, playing Go-Moku against a friend and you will both soon discover that it is not terribly difficult to force a double threat situation early in the game. For this reason it is often the rule that a double threat may not be created if both rows of three are capable of being extended into open rows of four. In some cases this restriction is only applied to Black, in order to offset the advantage of the first move.

Program Design

Since Go-Moku is a zero sum, two-person game, we can employ most of the tricks of the trade that have been discussed in earlier articles in this series. The program will grow and search a game tree, using some sort of evaluation function to evaluate terminal nodes on the tree. The obvious problem is the size of the tree itself—with 361 intersections on the board, even the alpha-beta algorithm will need to evaluate at least a quarter of a million terminal nodes when performing only a 4-ply search, and that assumes almost perfect ordering.

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Games, continued...

The true number is likely to exceed five million terminal nodes in a 4-ply search, which puts the whole concept of full width search under a big cloud where Go-Moku is concerned. We will therefore need to find some way to prune the game tree, but more about that later.

Evaluation

As I mentioned in an earlier article, there is always a trade-off between selecting a sophisticated but slow evaluation function, which provides a relatively accurate score for a game position, and the other extreme which is a fast but simple evaluation function which permits the search of a larger tree but which does not 'understand' so much when it is looking at a terminal node. William Blake once wrote: 'A fool sees not the same tree that a wise man sees' and his words of wisdom were clearly intended for programmers working on computer games.

In the case of Go-Moku, since the size of the game tree is so enormous, the use of a simple evaluation function with a deep tree search is clearly out of the question. In this sense, an important decision has been made for us by the very structure of the game itself. We must look at a relatively shallow tree, so we ought to ensure that our evaluation mechanism is wise rather than foolish.

Let's start by considering what features might usefully be incorporated in our evaluation function – we shall expand their scope a little further on in this article.

The key to a successful strategy is obtaining some of your own stones, in an unbroken row, in such a way that they could *conceivably* be extended into a row of five. Let us first define some variable.

W1 = the number of single white stones which are in a row, column or diagonal in such a way as to allow the stone to be extended into a row, column or diagonal of five stones.

Using the notation of Figure 1, imagine a white stone on D1 and black stones on A1, F1 and D5. There is no way that the stone on D1 can ever form part of a row or column of five stones, because the horizontal and vertical directions are sufficiently well blocked off by Black, but it *is* conceivable that the stone on D1 could form part of a diagonal of five stones, if White were to be able to place stones on E2, F3, G4 and H5. So in this case W1 would be 1, because this is the number of possible 5-rows that can be made using D1. If there were no black stone on A1 then the value of W1 would be 2 because D1 could be part of a horizontal or diagonal 5-row, and if there were no stone on D5 either the value of W1 would be 3, since 5-rows could be constructed horizontally, vertically and in one diagonal direction.

Similarly, B1 = the number of single black stones which are in a row, column or diagonal in such a way as to allow the stone to be extended into a row, column or diagonal of five stones (which we call a 5-row).

And W2, B2, W3, B3, W4, B4, W5 and B5 are the corresponding variables for situations in which White or Black has a row, column or diagonal with 2, 3, 4 or 5 of his own stones in an unbroken row.

Let us assume for the sake of simplicity that all terminal nodes are at even depth, that is to say we only evaluate a position in which it is the program's turn to move. We shall further assume that the program is White. It is now necessary to assign weights to the features of the evaluation functions in such a way as to reflect the worth of a 1-row, a 2-row, a 3-row, a 4-row and a 5-row. Of course a 5-row has infinite value, in the sense that if you make a 5-row you have won the game, so the weighting assigned to W5 and B5 should reflect this fact, in the same way that a chess-playing program would have an infinite value assigned to the kings.

Let the weightings which we assign to these variables be as follows:
AW1 is the weighting assigned to W1
AB1 is the weighting assigned to B1.

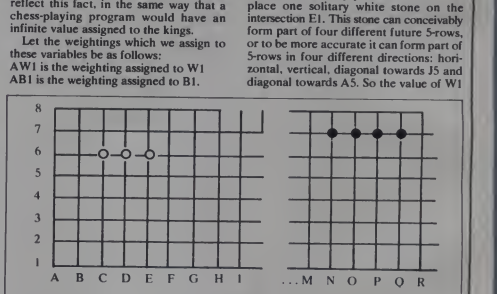

Figure 1.

Then the whole of the evaluation function takes the form:
(AW1 x W1) + (AW2 x W2) +
(AW3 x W3) + (AW4 x W4) +
(AW5 x W5) - (AB1 x B1) -
(AB2 x B2) - (AB3 x B3) -
(AB4 x B4) - (AB5 x B5)
By ensuring that the weightings increase as the indices increase (i.e. AW5 AW4 AW3, etc) we are using our evaluation function to represent the statement: 5-rows are more valuable than 4-rows which are more valuable than 3-rows which are more valuable than 2-rows which are more valuable than 1-rows. And if we ensure that AB5 lies between AW4 and AW5, and that AW4 lies between AB4 and AB5, and that AB4 lies between AW3 and AW4... etc., we are using the function to represent the statement: Make a 5-row if you can, otherwise prevent your opponent from making a 5-row of his own if you can, otherwise make a 4-row of your own if you can, otherwise prevent your opponent from making a 4-row of his own if you can, otherwise...etc. The actual values of the AWi and the ABi should be chosen by intelligent guesswork to begin with, and then modified in the light of experience. I have discussed how this might be done, manually and automatically, in earlier articles in this series.

Refinements to the Evaluation Function

The function described above is simple to understand and to program, yet it encompasses the most important aspects of the game of Go-Moku. Nevertheless, it is rather unsophisticated and I should like to point out ways in which it might be improved.

Consider an empty board on which we place one solitary white stone on the intersection E1. This stone can conceivably form part of four different future 5-rows, or to be more accurate it can form part of 5-rows in four different directions: horizontal, vertical, diagonal towards J5 and diagonal towards A5. So the value of W1 produced by that stone is 4, one for each direction. Now let us remove this stone from E1 and place it on J1. Is the stone of the same value on J1 as it was on E1? Since the value of W1 for the stone on J1 is also 4, just as it was for the stone on E1, it might seem at first as though the two stones *are* of equal value but they are not. Until the game nears its conclusion, much of the value of a particular 1-row, 2-row or 3-row lies in its potential as a threat – the opponent must react in some way to counter the threat. Therefore, part of the strategy of the game lies in placing a stone in such a way as to compel the opponent to reply to one threat and then taking advantage of a different threat which the opponent was unable to meet because he had to attend to something more immediate.

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CIRCLE 187 ON READER SERVICE CARD

Games, continued...

Let us consider the situation of two white stones on E1 and D1, with the rest of the board being irrelevannt. If we add a third white stone to C1, a serious threat since a white stone on B1 or F1 would have to react to this threat by placing a black stone on B1 or F1. White has then not accomplished anything in the horizontal direction because his play has now been blocked and if he puts a stone on F1 Black can counter on A1. But the placing of the third white stone on C1 might well have much deeper implications—it might be part of a plan to create a strong formation over on the left hand side of the board, with a view to extending this formation into a winning threat later in the game.

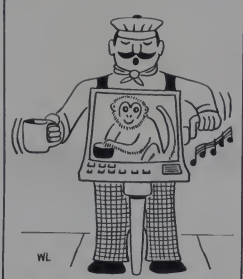
Now we come to the important difference between having a single stone on E1 and having it on J1. If the planned future activity is in the area of the A-column, B-column and C-column, it is less likely to be successful than if it is in the E-column, F-column and G-column, simply because in the former case this activity is bounded by the left hand edge of the board. If your area of activity is bounded in some way, either by an edge of the board or by a strong (or even impregnable) formation of your opponent's stones, you will be less likely to win than if your area of activity is not bounded. In the latter case you have more opportunity to use the area of activity to create further threats.

What does all this mean in relation to our evaluation function? The obvious implication is that the weighting should vary in some way that reflects the number of vacant intersections to each side of a 1-row, 2-row or 3-row. (The number of vacant intersections to each side of a 4-row is not important, since the 4-row itself will determine the outcome of the game at once.) In the above example it might appear as though the small number of intersections to the left of E1 might be compensated for by the larger number of vacant intersections to the right of E1, and that therefore, E1 and J1 *are* of equal value. But if we think about the nature of the game it is clear that having a formation near the center of a row, column or diagonal, gives greater flexibility than having that same formation near one or more edges of the board. We should therefore adjust our weightings in some suitable manner, to reflect the desire to have useful formations nearer the center than the edges. One possible way of doing this is to subtract from a weighting AWi (or BWi), an amount Ci, where Ci is inversely proportional to (1+ number of vacant intersections between the end of a formation and its nearest edge of the board (or enemy stone) in the same direction). Thus, for a single black stone on the D1 intersection of an otherwise empty board, the weighting AB1 would actually be AB1−(1/3), for the component of the score that is related to the horizontal 1-row. This is because in a horizontal direction the nearest edge intersection to the 1-row on D1 is the intersection A1, which is two vacant intersections away from D1. The weighting AB1 in the diagonal directions towards the left hand edge would be AB1−1/1; the weighting in the diagonal direction towards the right hand edge would be AB1−1/1 (these last three values are due to D1 being on the edge of the board).

The suggestion to subtract a value that is inversely proportional to the 'freedom of movement' of a formation is given here as an indication of the shape that this part of the evaluation function should take. You might find it more satisfactory to subtract the square of that number, or some other function.

Another important refinement of the evaluation function is needed to take care of those situations in which a stone of one color may have a nearby neighbor of its own color. For example, white stones on E1 and G1 with no other stones on the first horizontal row. The value of these two stones is clearly more than the value of two individual 1-rows, because the two stones can easily combine into a 3-row if White is permitted to play on F1. On the other hand, two white stones with one vacant intersection between them are worth slightly less than a 2-row because with a 2-row there are four distinct ways of creating a 5-row, whereas with two separated 1-rows there are only three distinct ways (since the vacant intersection between them *must* be occupied). This leads me to suggest that in a situation of this type we employ a weighting mid-way between that of a 2-row and the sum of two 1-rows. If there are two vacant intersections between the two 1-rows, use a weighting one quarter of the way between that of two 1-rows and that of one 2-row, and if there are three vacant intersections take a weighting one eighth of the way between them. Similar logic can be used to suggest weightings for (say) a 1-row separated from a 2-row (in the same horizontal, vertical or diagonal) by one or two vacant intersections, though here as usual, your first guesstimate as to the size of the weighting will almost certainly need to be changed in the light of experience.

The two refinements discussed here are probably necessary for a very strong program, but those of you who wish to keep things simple will, I'm sure, get an entertaining game from a program which employs only the most primitive form of the evaluation function.



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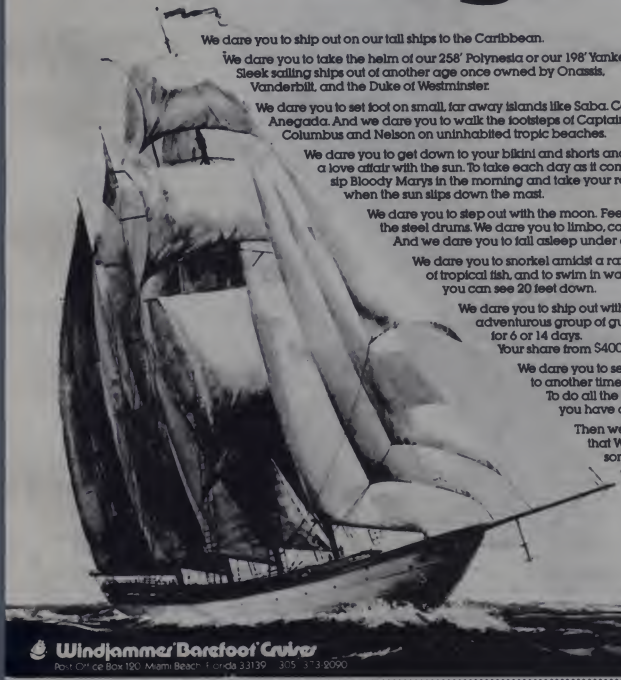
Combatting Enormous Tree Growth

The potential size of the Go-Moku tree forces us to introduce some sort of forward pruning from the very first ply of search. The simplest way to do this is to employ the evaluation function also as a plausibility indicator. First your program generates a list of all the legal moves in the root position. (In fact it has this list readily available and updates it whenever a move is made in the tree—the updating consists simply of removing a now occupied intersection from the list of legal moves.) The program then evaluates all the resulting positions at ply-1, using the evaluation function, and sorts the moves into descending order of merit based upon these evaluations. The worst n percent of the moves on the list may then be discarded (n can be chosen to suit the execution speed of your program—I would suggest that you start with n = 90). You will now have a list of some 36 moves (at the start of the game) and from each of the 36 positions you again generate and evaluate, discarding the worst (say) 92 percent of the moves at the next ply. The percentage of moves discarded goes up as the tree gets deeper and deeper, and this parameter can be adjusted, dynamically if necessary, so that the program is made to respond in any desired time frame.

Your tree will now be no larger than the tree for a chess program, and move generation will be faster than for chess, so provided you code the evaluation routine in an efficient manner, you ought to be able to perform a search of 4-6 ply within a minute or two, if your program is written in assembler.

Those of you who have been following my earlier articles will already have encountered the concept of the alpha-beta window and the killer heuristic, both of which should be employed in your Go-Moku program. In a large tree the killer

We dare you.



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In our early growth years when we had 5,000 and then 10,000 subscribers we couldn't imagine we would ever need more than 1000 extra copies for back issue sales. That's about what we printed extra. However, by the time we were going into Volume 3, we found our stocks of Volume 1 issues virtually depleted.

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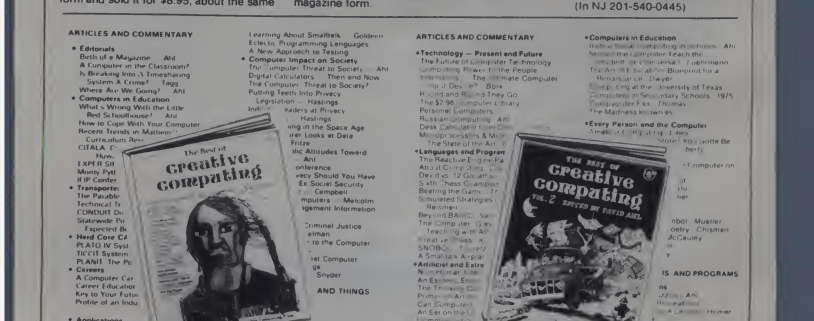
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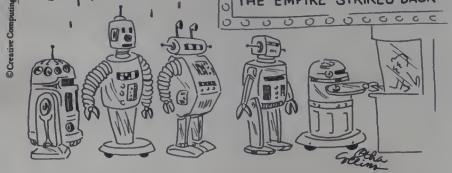
Games, continued...

heuristic is particularly useful and the fact that you have sorted the moves prior to generation of the replies at each level will help considerably in the optimization of the alpha-beta routine itself. One other method of speeding the search is to avoid the need to re-evaluate those parts of the board that are not affected by a move in the game tree. You might, for example, keep several different components of the evaluation, and update only those affected by a move. For example, let us assume that the evaluation function has separate components for each horizontal, each vertical and each diagonal. If the program considers a move on the intersection A1, this move will in no way affect the evaluation of a formation in the J column, so part of the evaluation process need not be repeated—it is known to be unchanged. The more you speed up the evaluation process, the deeper the tree can grow, so any technique which updates the evaluation function in an incremental way is certain to be useful.

Tactical Search

In most board games it is possible to distinguish strategic play from tactical play. We have discussed this point before, with particular reference to chess and it is well known that the tree search should look deeper in those parts of the tree that are of greater tactical interest. In Go-Moku, tactical play is represented by threats, counter threats and moves that defend against threats. We have seen how the very existence of a 3-row constitutes a threat and it would be possible to argue that the creation of a 2-row is a veiled threat since the 2-row can easily grow into a 3-row. But I would recommend that we assume the evaluation function will be sufficiently smart to provide scores that represent fairly accurately the value of having a 2-row. It is the tactical value of a 3-row that is not so easy to measure and your program should therefore consider any move which creates a 3-row as being worthy of further consideration, even if it would otherwise be a terminal node.

My suggestion for a tactical search is to examine any move which creates or blocks a 3-row or a 4-row or which creates a 5-row. This means that having grown the tree to what would normally be its full depth, the program examines the board to see if any 3-rows exist and if so, whether the opponent can block them. The program also examines moves which themselves create 3-rows. It does the same for 4-rows and it looks for moves which create winning 5-rows. This process can, particularly during the later stages of the game, lead to a substantial increase in the size of the tree but tactics are extremely important in Go-Moku and it is essential for a strong program to have a good command of tactics. In order to be able to extend the tactical search to (say) 4 or 6 ply beyond the usual depth of search, it may be necessary to reduce the depth of the first part of the search. To ensure that your program responds within an acceptable amount of time, you should make your tree search iterative, with a mandatory cutoff after a certain maximum number of seconds. Your program might then perform a full 1-ply search, plus (say) 6-ply of tactical search; then if it has not consumed all of its thinking time it can sort the 1-ply moves as suggested above, prune off 90 percent of them, generate the replies to the remaining ten percent and then perform a 6-ply tactical search from the resulting positions at depth 2-ply. Once again, if the search time is not exhausted, prune 92 percent of the second ply moves, generate the third ply moves and perform your 6-ply tactical search. In order to optimize the performance of your program, try playing around with the various parameters (not only the weightings in the evaluation functions, but also the percentage of moves pruned at each level and the depth of tactical search). □



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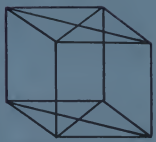
A Hole In One

Buzzsaw Bailey dropped into the Grits-N-Bits coffee shop the other day and told everyone about a puzzle he had just heard from a lumber salesman. The salesman showed Bailey a square piece of wood with a small hole drilled in it off center.

"The problem," he told Bailey, "is to figure out the least number of pieces the board would have to be cut up into so that when you reassembled the pieces the hole would now be in the center of the board." Bailey left the piece of wood at the Grits-N-Bits and went home without telling anybody how it was done. Can you tell the folks at the coffee shop how to solve this puzzle? (From the book *Merlin's Puzzler 2* by Charles Barry Townsend and published by Hammond, Inc.

The Brain Buster

The gentleman pictured here, whose vocation obviously deals with numbers, is vainly trying to solve a mathematical puzzle in his head. The problem is a formidable one. You must add up all of the numbers from 1 to 100. Mr. Quiller has been working on this addition for over five minutes and he keeps losing track of which number he added last. What Mr. Quiller doesn't know is that there is a simple solution to this problem that would allow him to solve it in 20 seconds or less. Can you discover what this solution is?



The Third Dimension Puzzle

Our next problem should keep you busy with pencil and paper for quite awhile. Mr. Bruce Roland, of Meadville, PA, writes: "You are to draw the three-dimensional figure shown here with one continuous line. At no point can the line cross itself. However, you must keep in mind that this is a three-dimensional figure and some of the lines will go *behind* and *under* as well as *over* and in *front* of other lines."

In other words, although you are drawing this figure on a two-dimensional surface, you must pretend that you are drawing it in space. When one line crosses another line it may really be going behind it. For this outer-space puzzle Merlin is sending Mr. Roland a copy of *Merlin's Puzzler 2*, a three-dimensional storehouse of puzzles and fun.

Double Trouble

Here are a couple of quickie (?) puzzles for you to work on. Below are pictured two simple equations. You must substitute the numbers 1 through 9 for the letters so that the equations are correct.

$$A \times B = CD$$

$$CD \times EF = GHI$$

The Picnic Puzzle

At the turn of the century Sam Loyd was America's favorite puzzle master. Try your hand at solving his famous "Picnic Puzzle."

"When they started off on the great annual picnic every wagon in town was pressed into service. Half way to the grounds ten wagons broke down, so it was necessary for each of the remaining wagons to carry one more person.

When they started for home it was discovered that fifteen more wagons were out of commission, so on the return trip there were three persons more in each wagon than when they started out in the morning.

Now, who can tell how many people attended the great annual picnic?"

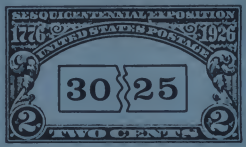
The Puzzle Club
WILBUR CHALLENGED ANTOINE TO DIVIDE A PIZZA INTO EIGHT PIECES.
THIS IS THE BEST PUZZLE I'VE EVER EATEN! FOR ONCE I'M ON WILBUR'S CORNER.
THE TRICK WAS TO DO IT USING ONLY THREE CUTS OF THE PIZZA KNIFE.
WILBUR, HE MAKE A FOOL OF ANTOINE WITH HIS SILLY PUZZLE! I HAVE RUINED ALL OF MY LUNCHEON PIZZAS!

The Puzzle Club

At the left is a panel from a cartoon/puzzle that we call *The Puzzle Club*. This cartoon strip will be a regular feature in MERLIN's new activity magazine. Vote for MERLIN today!!!

The Sesquicentennial Puzzle

Merlin was showing me part of his stamp collection the other day when he ran across an interesting stamp commemorating 150 years of American puzzling. The particular stamp shown below depicts the famous "Broken House Number" puzzle. The puzzle, in brief, states that a house number sign, with a four digit number printed upon it, fell down and broke in half. It was noted by the owner of the house that if you added the two digit number on one piece to the two digit number on the other piece and then squared the result you would have a number equal to the original house number. (How he ever casually noticed this is beyond me.) That is: 30 + 25 = 55; 55 x 55 = 3025. The owner then set about determining how many other four digit numbers would yield the same results if they were "broken" in two. Why don't you try solving this problem on your computer? You might also see if there are any six digit numbers that would yield this type of result.



The Three Prisoners

From one of Merlin's puzzling cousins across the sea comes this interesting presentation of an old problem. For his efforts Mr. Dan Simpson, of Sheffield, England, will receive a copy of *Merlin's Puzzler 2*. Now for the problem:

"Three programmers had been thrown into jail for writing unreliable software. They were all gloomily sitting in their cell waiting for dawn, when they were to be executed. As luck would have it that day was the birthday of the President of IBM and he decreed that he would grant the life of one programmer. The jailer, who was a frustrated computer user, decided on a fair way to choose who would be released.

On the stroke of midnight the jailer entered the cell and spoke as follows to the three programmers. "You will see that I have three yellow hats, three green hats and three blindfolds. I shall blindfold you all and then place one hat on each of your heads. After I have removed the remaining hats out of sight I shall remove your blindfolds and if you can then see a yellow hat on the head of a prisoner you should raise your hand. Freedom will be granted to the first person to tell me the color of the hat on his own head."

This he proceeded to do. Each prisoner looked warily at the other two and they all raised a hand, in fact they could all see two yellow hats.

After a short time one prisoner (the one who read *Creative Computing*), smiled to himself, had a word with the jailer and walked to freedom.

What color was his hat and how did he know?"

Answers on page 424.

YOUR LAST CHANCE TO CHANGE THE COURSE OF HISTORY

Yes, fellow puzzlers, this is your last chance to help MERLIN launch a great new activity magazine. In case you missed the last two issues of *Creative Computing*, MERLIN wants to publish a magazine devoted to puzzles, games, riddles, quizzes, crossword puzzles, contests, stunts, mazes, The Victorian puzzles of Professor Hoffmann, a Dungeons and Dragons type puzzle/game, magic, puzzle cartoons like The Clue Club and The Puzzle Club, a cartoon version of the Change-The-Word puzzle that our readers like so well, and many, many other activities that could only be presented in a magazine produced by MERLIN. All of this can be yours if you *act* today! *MERLIN needs to know* that he has *your* backing in this project! After all, when he goes to see the Chancellor of the Exchequer it's numbers that count, not guesses.

So, give the old boy your support and fill out your ballot today! Remember, *your vote really counts*!! Five minutes of your time today will get *you* a great magazine tomorrow!!!

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CIRCLE 128 ON READER SERVICE CARD

Guide to Microcomputers, by Franz J. Frederick. Association For Educational Communications and Technology, 1126 16th St. NW, Washington, DC 20036. 158 pages, paperback $11.50. 1980.

Owning Your Home Computer, by Robert L. Perry. Everest House, New York. 224 pages, paperback $10.95. 1980.

Without Me You're Nothing: The Essential Guide to Home Computers, by Frank Herbert with Max Barnard. Simon and Schuster, New York. 391 pages, hardcover $14.95. 1981.

Although "assembled for the educational community" and prepared with funding from the National Institute of Education, the *Guide to Microcomputers* is of interest to anyone considering the machines the book focuses on: Apple II, TRS-80 (Model I), Exidy Sorcerer, Ohio Scientific C4P, Commodore/CBM/PET, Atari 800, and Texas Instruments 99/4.

The first six chapters are useful to both educators and laymen: introduction, languages, disk operating systems, components of a system, peripherals, and service and maintenance. The writing is quite detailed and entirely objective, without bias toward or against any system.

The last eight chapters are mainly for educators: computer-assisted instruction (CAI), timesharing and resource sharing, instructional and media-center applications, microcomputer projects in public schools, special applications, (electronic mail, networks, videodiscs), journals and magazines, software companies, and books, program guides and sources of educational programs.

The last three chapters provide excellent, long and detailed lists of resources of interest to all. This is probably the best and perhaps the only) guide for educators, and despite being a little out of date (the Model I TRS-80 is no longer made), is crammed with more useful information than most other guides.

Owning Your Home Computer is one of the most helpful, complete and well-written books available, not only as a guide for selecting a home computer, but for understanding companion areas such as networking, videotext, and help for the handicapped.

Fifteen chapters cover The Home Information Explosion (mainly videotext), home computers, The First Generation (early machines), How to Buy a Home Computer, recent computers, The Handiest Home Computers (TRS-80, PET, Apple, OSI, Compucolor, Sorcerer, Atari, etc.), networks, The Mind Appliance, Ninety-Nine Common Things to Do with a Home Computer, educational uses, Home Computers in Your Work programming, Help for the Handicapped, home control, and the Thinking Computer of the Future.

As for those 99 Common Things, they include: play games, hold game tournaments, create stories, compose and play music, learn computer languages, learn advanced math, manage family diets, analyze private portfolios, do word processing/text editing, and many more.

Perry has obviously taken a great deal of time to make this a fine book with a wide coverage of home computers and

reviews...

adjacent areas. The book uses many pictures chosen for illustrative purposes and not just to pad out the book. The descriptions of the Handiest Home Computers include lengthy paragraphs on system description, memory, peripherals, disk drives, printers, software, and system prices.

The appendix lists 1,050 home computer programs, by supplier and by category. A 4 1/2-page glossary is followed by a page listing 20 helpful books and six magazines.

Although there are a couple of pages on computers that haven't become popular, or which dropped quickly out of sight, such as the Bally Arcade, this happens with every such book, which begins to be out of date as soon as the writer finishes.

Without Me You're Nothing may be the first guide to home computers written by a famous author. Herbert has written over a dozen works of fiction, including the Dune series, which deal with the desert world Arrakis.

According to the last sentence in the book, "Along with Max Barnard, Herbert has been devoting his time recently to developing his own home computer system which will operate his household appliances, manage his finances and help him produce his books."

The first half of this book is so general that only two recent computers are mentioned by name: the MITS Altair, which went out of production some time ago; and the DEC PDP-11 family: "If money is no object, by all means consider the PDP-11."

In the second half, Herbert, who believes the "the present philosophy of flowcharting stinks," comes up with his own approach, called Programap, which uses some 20 symbols that represent the different programming operations, such as a square containing a black rectangle and two knobs to represent a CRT screen, and a triangle hanging from a horizontal line to mean GOTO. These and the others are connected by the usual lines with arrows, and line numbers are added here and there, along with a column of brief descriptive phrases.

Appendixes provide two programs in both Programap and heavily annotated Basic, for car maintenance and for mortage-interest payments.

The writing is very good, but a guide to home computers that names only the Altair and PDP-11, isn't much of a guide. There's a list of microcomputer manufacturers, which includes Hughes Aircraft Co., International Data Systems, and Sphere Group.

For a real guide, get one of the other two reviewed here, which are among many that provide much more help, and cost less.

Microprocessor Background For Management Personnel, by James Arlin Cooper, Prentice-Hall Inc., Englewood Cliffs, NJ, 173 pages, hardcover $14.95, 1981.

The need for a book of this type became apparent to the author, according to the preface, while working on a microprocessor course for management personnel at Sandia Laboratories, where he is a division supervisor. This book was written for managers of technical people "who need to understand microprocessor basics without becoming expert users."

Twelve chapters cover Background, Basic Principles, Data and Instruction Processing, Programming Techniques, Input/Output, Bit-Slice Structure, Design Examples, Applications,

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The General Ledger is $150.00 and may be used as a stand-alone system. The AR, AP and PR subsystems require the GL subsystem for proper operation. GL plus one subsystem is $250.00; GL plus two subsystems is $325.00 and the complete package is $395.00. NOTE: the new IAS requires a 24 × 80 cursor-addressable terminal, 48K of memory and one 8" or two 5¼" disk drives. CP/M™ users must have the SoHo Group's Matchmaker, which we will provide free to the first 100 buyers of the complete IAS package ($110.00 value). Matchmaker may otherwise be ordered with any IAS subsystem for $75.00.
The IAS operator's manual may be purchased for $25.00 (credited towards purchase). Please specify 8" SD (soft sectored) or 5¼" North Star disk and CRT type when ordering.
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views... book reviews..

The Selection Process (selecting hardware), Project Management Problems, Prognosis (the future), On Keeping Current (magazines, books, courses).

Four appendixes cover computer mnemonics, glossary, microprocessor types (1802, 8080, etc.), and hex coding.

The text gets quite technical in some places, showing, for example, a gate-level schematic of "data flow during addition"; examples of a stack push-pop routine; complex flowcharts, in the design-examples chapter, of a war game, shooting gallery game, and an electronic combination lock; and schematics of the various basic microprocessor technologies (TTL, ECL, PMOS, etc.).

The is the kind of book a manager can read from cover to cover if he needs or wants to know as much as possible, or skip over the heavier material without losing too much background essential for understanding later chapters, as can happen with nearly all computer textbooks.

The writing is straightforward and direct, putting as much information as possible into each paragraph, page and chapter.

Using CP/M, by Judi N. Fernandez and Ruth Ashley. John Wiley & Sons. Inc., New York. 253 pages, paperback $8.95. 1980.

Another in the Wiley series of Self-Teaching Guides, this book, according to the back cover, will teach you to "create, erase, and copy files, run other programs, translate and test 8080 Assembler language programs, print data from files, display the directory of a disk, and more."

CP/M, or Control Program/Microprocessors, is a disk operating system for microcomputers based on the 8080, 8085, and the Z-80 type microprocessor chip. It is a software package developed and distributed by Digital Research, and has become the most common microcomputer operating system, according to page vii.

This book assumes you have a microcomputer and a CP/M package. The ten chapters are divided into frames. Information is presented, followed by questions that ask you to apply the information. The correct answers to these questions follow a dashed line after the frame, so you cover up the answers until you've written yours in the space provided.

The ten chapters cover an introduction, Typing CP/M Commands, CP/M Built-In Commands, CP/M Transient Programs, The STAT Command, Using PIP, Introduction to ED, Editing Existing Files, Advanced ED Functions, and submitting Command Files. Three appendixes cover Changing Device Assignments, PIP Parameters, and Reference Summary.

The book assumes that if you've gotten as far as buying a CP/M package, you understand enough about computers that it isn't necessary to teach the basics. Nevertheless, all computer jargon used is explained, such as *20K bytes*, *floppy disk*, and *video terminal*. So if you're not all that familiar with computers, this book provides what is probably the easiest way to learn about CP/M.

So You Are Thinking About a Small Business Computer, by the staff of *Computing in Your Business*. Canning Publications Inc., 925 Anza Ave., Vista, CA 92083. 104 pages, paperback $12.50. 1980.

This book is "especially suitable," according to the letter accompanying it, for "(1) small business owners and managers with limited or no previous experience who are in the process

of selecting their first computer; and (2) computer professionals whose friends are asking them for help in selecting a small computer."

Although the book has only 96 pages of text, it is large, 8 1/2" by 11" in size and it's from the company that has been publishing since 1963 the well-known and authoritative *EDP Analyzer*, from which many pointed examples have been taken and placed amid the wealth of advice and common sense presented here.

The ten chapters cover How a Computer Can Help You, How Computers Work, Hardware, Software, Vendors, The First Step—Familiarization, Selecting a Complete System, If Custom Programming is Needed, Using a Consultant, and What the Future Holds.

The first appendix provides six pages of computer terms; the second, Some Leading Suppliers: major manufacturers (Burroughs, Honeywell, IBM, NCR, Sperry Univac), mini manufacturers (AM Jacquard, Basic Four, Data General, DEC, Hewlett-Packard, Microdata, TI, Wang), micro manufacturers (Apple, Cromemco, North Star, Ohio Scientific, Radio Shack, Vector Graphics), turnkey system suppliers (Cado Systems, Qantel), remote computing services (ADP, Boeing, GE, etc.).

This may well be the most practical of such guides, with much guidance in areas such as what can be expected (in customer support, marketing, peripherals, etc.) from manufacturers in the three groups, where to find software packages, vendor characteristics, "what *not* to do" if customer programming is needed, precautions regarding consultants, etc. The photos are few but good; the book is thin but crammed with help.

Basic-Pack Statistics Programs for Small Computers, by Dennie Van Tassel. Prentice-Hall Inc., Englewood Cliffs, NJ. 239 pages, paperback $16.95, 1981.

This book of 33 statistical programs has two purposes, according to the preface: each program provides several statistical measurements, so the person using them "should be able to process much of their statistical data for small samples with the enclosed programs"; and second, "these programs can be used to develop an understanding of statistics."

The third book in the Prentice-Hall Series On Personal Computing, it includes programs for descriptive statistics plus T-statistic, chi-square, independence, and two-sample tests, plus examples and exercises designed to "teach the user how to use the programs. . . . While using the programs, the user can enter in several sets of varying data and see how the output statistical measurements vary as the input data varies."

Each program is presented in three parts: description, sample run, and a listing. The Basic used is described as being at a level that will make the programs transferable to most computers. Each program description contains a "bugs" paragraph that describes any deficiencies or limitations in the programs.

Van Tassel, who has written frequently for *Creative*, writes very clearly and as simply as possible. His book provides a painless way to learn about statistics. If you like it, you may be interested in his second book of statistical programs, in preparation at this writing. Hopefully the printouts will use a newer printer and/or ribbon than some of the early ones in this book, which are a little hard on the eyes. A minor problem, however, in an otherwise excellent book on a complex subject made simple and readable. □

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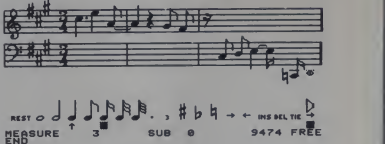

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I myself have told several people that next to a disk, I consider the [ALF] synthesizer to be the most important peripheral they could purchase for their system. Very excellent job! Keep up the good work.
—Oak Ridge, Tennessee

I recently purchased 2 of your Apple music boards. Out of the peripherals I have for my Apple, I enjoy them the most. It has to be the most enjoyable thing that has ever been invented. I hope you continue to develop products as clever and enjoyable as this one. The Entry program has to be one of the most sophisticated programs I have ever seen. It proves that a hardware manufacturer DOES have the ability to also produce quality software. It is almost worth the price of the boards just for the Entry program.
—Burbank, California

About ease of use:

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—Cypress, Texas

ALF has opened up my head and ears and enabled me to do things musically which I would like to be able to do on [conventional] instruments. As much as I love the instruments I try to play, I just don't have the talent and technique to play what is in my head. By golly, the ALF board doesn't know about my limitations, though. I can play hell out of that thing, playing notes and tempos which previously have existed only in my head. Many thanks from a frustrated musician and satisfied ALF "player".
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About the competition:

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—Kirkland, Washington

I would like to tell you that after having used the system ONLY ONE DAY, that I am absolutely delighted with it. In addition, I purchased the three boards although I ALREADY own Mountain Hardware's music system. Now that I have seen and own your system, I am putting my "old" one up for sale. I think that your software makes it far easier to enter music, and that the software routines allow for far greater flexibility. Again, I extend my compliments to you. As I said, I have owned another music system, and consider myself therefore, qualified to make a judgement between the use of the two. Yours is the clear choice!
—Levittown, New York

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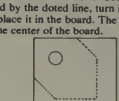
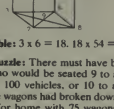
puzzle answers

A Hole In One: The least number of pieces the puzzle can be done in is two. Cut out the piece outlined by the dotted line, turn it end for end and replace it in the board. The hole will now be in the center of the board.



The Brain Buster: Try pairing the lowest and highest numbers: 1 + 100 = 101; 2 + 99 = 101; 3 + 98 = 101; etc. In the set of numbers 1 through 100 there are 50 such pairs. Thus, 50 x 101 = 5050 would be your mental solution.

The Third Dimension Puzzle: First, number the corners and where the X lines cross as shown in the diagram. Then draw one continuous line between these points as follows: Go from 1 to 5 to 6 to 2 to 10 to 1 to 3 to 7 to 9 to 3 to 4 to 8 to 7 to 5 to 10 to 6 to 8 to 9 to 4 to 2 to 1. Do this in this order without lifting the pencil.



Double Trouble: 3 x 6 = 18. 18 x 54 = 972.

The Picnic Puzzle: There must have been 900 picnickers who would be seated 9 to a wagon if there were 100 vehicles, or 10 to a wagon after 10 of the wagons had broken down. When they started for home with 75 wagons, it was necessary for 12 persons to ride in each wagon.

The Puzzle Club: Slice the pie in half. Slice it in half again the other way. Stack the four pieces on top of each other. Cut the stack in half. You now have 8 pieces from just three cuts of Antoine's knife.

The Sesquicentennial Puzzle: There are only three four digit numbers that yield this result: 9801, 2025, and 3025.

The Three Prisoners: The hat was of course yellow. Call the three prisoners A, B and C and let A be the one who gained his freedom. Prisoner A argues as follows: Consider the case where one hat is green (it must be mine) then another prisoner (say B) would argue, I (B) can see yellow on C, C can't see his yellow and A has green, so I (B) must be the yellow C can see so I (B) must be yellow. But no one argued this way so we can't have the case where one is green. So I (A) must be yellow.

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